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Field Assessment of Aerated Lagoon Emissions and Their Control Using an Inflated Dome

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Environmental Protection Agency, Cincinnati, OH

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Field Assessment of Aerated Lagoon Emissions and Their Control Using an Inflated Dome

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The fates of volatile organic compounds (VOC) in an industrial wastewater activated sludge system were investigated in a 4-day sampling and analysis program. The system included an aerated lagoon which was covered by an inflated synthetic dome and had a carbon adsorption unit to reduce the emissions of odorous organic compounds. Samples of air, water and sludge streams associated with the activated sludge system were collected, along with air samples at the inlet and outlet of the carbon adsorber. These samples were analyzed to determine the concentrations of individual organic constituents. The effectiveness of the dome and carbon adsorption unit in reducing lagoon emissions of volatile organic compounds was investigated, as was the applicability of the Thibodeaux, Parker and Heck model for predicting lagoon emissions. Approximate percentages of removal of VOC by biodegradation, adsorption and volatilization in the aerated lagoon were determined.

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of solid and hazardous wastes. These materials, if improperly dealt with, can threaten both public health and the environment. Abandoned waste sites and accidental releases of toxic and hazardous substances to the environment also have important environmental and public health implications. The Hazardous Waste Engineering Research Laboratory assists in providing an authoritative and defensible engineering basis for assessing and solving these problems. Its products support the policies, programs, and regulations of the Environmental Protection Agency, the permitting and other responsibilities of State and local governments and the needs of both large and small businesses in handling their wastes responsibly and economically.

The subject of this report is the control of volatile organic emissions from hazardous waste treatment, storage and disposal technologies. The results and conclusions of this report can be used to determine the technical and economic feasibility of controlling volatile organic emissions from treatment, storage, and disposal facilities (TSDFs). Those who would find this report of use include TSDF owners/operators, hazardous waste regulatory personnel, and engineers concerned with emissions from TSDFs and engineering unit operations to reduce these emissions. For further information, contact the Alternative Technologies Division, Hazardous Waste Engineering Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

Thomas R. Hauser, Director
Hazardous Waste Engineering Research Laboratory

ABSTRACT

The fates of volatile organic compounds (VOC) in an industrial wastewater activated sludge system were investigated in a 4-day sampling and analysis program. The system included an aerated lagoon which was covered by an inflated synthetic dome and had a carbon adsorption unit to reduce the emissions of odorous organic compounds. Samples of air, water and sludge streams associated with the activated sludge system were collected, along with air samples at the inlet and outlet of the carbon adsorber. These samples were analyzed to determine the concentrations of individual organic constituents. The effectiveness of the dome and carbon adsorption unit in reducing lagoon emissions of volatile organic compounds was investigated, as was the applicability of the Thibodeaux, Parker and Heck model for predicting lagoon emissions. Approximate percentages of removal of VOC by biodegradation, adsorption and volatilization in the aerated lagoon were determined.

This report was submitted in partial fulfillment of EPA Contracts 68-02-3850 and 68-02-3994, by the Radian Corporation under the sponsorship of the U. S. Environmental Protection Agency. This report covers a period from April 1984 to February 1986, and work was completed as of April 1986.

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SECTION 1

INTRODUCTION

The U.S. Environmental Protection Agency is developing standards to control emissions from hazardous waste treatment, storage, and disposal facilities (TSDFs). The purpose of these regulations is to protect human health and the environment from impairment by emissions of volatile organic compounds (VOCs) and particulate matter. This regulatory development was originally the responsiblilty of the Technology Branch of the Office of Solid Waste, but the program was transferred to the Office of Air Quality Planning and Standards (OAQPS) in January, 1984.

The Hazardous Waste Engineering Research Laboratory (HWERL) has the responsiblity of providing technical support to OAQPS in the area of atmospheric emissions from hazardous waste management. In part, the HWERL program is designed to develop information on emission control techniques applicable to TSDF's. Potentially applicable controls include 1) clean up of off-gases from waste handling processes, 2) process design changes or direct-contact covers which reduce mass transfer of volatiles from the waste to the air, and 3) treatment of wastes for VOC removal.

PROJECT OBJECTIVE

The objective of this project is to obtain field measurements of the effectiveness of emission controls for off-gases from waste handling processes. This was met through a test program at a lagoon enclosure. Specifically, the three primary objectives of the lagoon enclosure testing were to:

- measure the control efficiency of the activated carbon beds which were used in the treatment of the off-gases from the lagoon;
- measure the overall effectiveness of the dome and carbon adsorption system in controlling lagoon emissions: and
- determine the validity of Thibodeaux's model for predicting emission rates from aerated impoundments.

As part of the assessment of lagoon emissions and their control, an approximate mass balance was performed around the lagoon and the complete wastewater treatment system to determine the fate of influent VOCs. Also, the effectiveness of 55 gallon drums of carbon used to control breathing and working losses in the pretreatment area was determined.

SITE DESCRIPTION

The TSDF site chosen for examination in this study is located at Upjohn Fine Chemicals in North Haven, Connecticut. At this facility Upjohn produces specialty chemicals as intermediates for other Upjohn divisions and for sale to other end users. The wastewater generated from these operations may result in a hazardous waste. The wastewater is treated in a series of processes (neutralization, primary clarification and activated sludge) prior to being discharged. The site was chosen because of the emissions control system used at Upjohn to minimize odor. This system is located at the aerated lagoon that is part of the activated sludge system. Control consists of an inflated dome over the lagoon with carbon adsorption beds to remove odorous compounds (primarily orthochlorophenol) from the exhaust gases. While orthochlorophenol is not volatile, the facility wastewaters do contain aromatic and halogenated organic compounds which are volatile. The dome and carbon adsorption system at Upjohn was studied to determine its efficiency in controlling volatile emissions. Also, as a secondary test objective, small disposable drums of activated carbon used for odor and emission control from the neutralizer and primary clarifier tanks in the wastewater treatment system were studied to determine their effectiveness.

TESTING PROGRAM

Emission measurements were performed at the Upjohn facility during the week of August 13 through 19, 1984. Testing was conducted by Radian Corporation, under the direction of Bart Eklund and Dr. Robert Wetherold. Process data were obtained by Thomas Nelson of Radian Corporation. Representatives from the Environmental Protection Agency and S-Cubed, Inc., observed the testing.

The following sections of this report contain the results of the testing and also the emission modeling work. Section 2 presents a summary of the results. Section 3 provides a site description, Section 4 lists the sample locations, and Section 5 gives the sampling and analytical procedures. Section 6 provides complete summaries of the test results. Section 7 contains the measured emission rates and Section 8 shows the results of the emission modeling. Finally Section 9 discusses QA/QC and data quality. Appendices A through S provide facility operation data, sample calculations and sampling and analytical data that are pertinent to the report.

SECTION 2.0

SUMMARY AND DISCUSSION OF RESULTS

The Upjohn hazardous waste treatment, storage and disposal facility (TSDF) was tested during the week of August 13 through 19, 1984. The facility is located in North Haven, Connecticut and produces a number of specialty chemicals used as intermediates. The processing wastewater (and some slurry solids) are treated in an enclosed aerated lagoon. The testing in this report centers on the emissions associated with the wastewater treatment facility aerated lagoon and ancillary equipment.

The non-methane hydrocarbon compounds (NMHC) in the influent stream to the TSDF can be generally classified as paraffins, aromatics, and halogens. Specific major compounds include 1,2-dichloroethane, benzene, toluene and chlorobenzene. At Upjohn, the influent NMHC enters an aerated lagoon where the various species experience apparently differing fates. A unique feature of the aerated lagoon is a flexible, air-tight, PVC-coated-polyester dome covering the entire aerated lagoon. The dome's form is maintained by a positive pressure inside the dome provided by a recirculating blower system. The dome is also continually purged by a slipstream exhaust stream. The exhaust stream is passed through an activated carbon bed for odor control. Sludges produced by the aerated lagoon are removed by a clarification/centrifuge system and the treated wastewater is discharged directly into a nearby river.

An approximate material balance performed around the Upjohn aerated lagoon indicated that the majority of the influent NMHC (approximately 60 weight percent) is volatilized and exhausted from the dome structure. The volatilized organics are primarily halogenated organic compounds (i.e. 1,2-dichloroethane). Approximately 30% of the influent NMHC is indicated to be contained in the wastewater sent to the secondary clarifiers. Biological oxidation in the lagoon was estimated by difference (i.e., mass balance closure), and was indicated to be approximately 10% of the influent NMHC. However, the 95 percent confidence interval for the biodegradation term indicated that biodegradation of NMHC cannot be determined by difference with 95 percent confidence.

The approximate material balance for aromatics indicated that the majority of the TSDF influent aromatics are degraded by biological activity in the aerated lagoon. Moreover, the 95 percent confidence interval for the term indicates that biodegradation is occurring. Paraffins appear to be generated in the lagoon (possibly as a result of aromatics biodegradation). However, this cannot be determined by material balance calculations (biodegradation calculated by difference) with 95 percent confidence.

An approximate NMHC material balance was performed around the overall Upjohn wastewater treatment facility. The results of this balance indicated that approximately one-third of the influent NMHC are volatilized and exhausted from the carbon adsorber system. The majority of the influent NMHC (approximately 60 percent) however, are contained in filter belt sludge. The other effluent streams (centrifuge sludge and wastewater) are estimated to each contain approximately 5% of the influent NMHC.

Uncertainty analyses using a Monte Carlo simulation were performed for each of the approximate material balances. These analyses were used to estimate 1) the relative standard error (i.e., relative standard deviation of the mean) associated with each term in the balances and 2) 95 percent confidence intervals for balance closure and/or the biodegradation terms calculated by difference.

The carbon adsorber on the dome exhaust provides virtually no major NMHC removal. This is primarily because (1) the system was not designed for bulk NMHC removal and (2) the extremely high (100 percent) relative humidity in the carbon adsorber inlet gas stream interferes with the adsorption capability of the carbon. The activated carbon bed system was originally designed for odor control, and Upjohn feels that the system is performing this function effectively.

Fifty-five gallon drums of activated carbon are used on vented emissions from the neutralizer tanks and primary clarifier at the TSDF. Testing indicated that these drums work very well in removing NMHC emissions in the vent gas. Removals over 99% were measured for specific hydrocarbon compounds.

Finally, mathematical models developed by Thibodeaux-Parker-Heck were used to predict the NMHC emission rates from the Upjohn facility. The predicted rates were compared to the measured emission rates. In general, the models are inconsistent in their abilities to predict actual emission rates. Also, the inability to analytically measure key model variables tend to limit the accuracy of the models.

The analytical results, including speciation, appear to be reproducible and compare favorably with previous test results obtained by Upjohn. The quality control results indicated a relative standard deviation of ±21.2% for off-site gas analysis, ±5.7% for on-site gas analyses and ±25.0% and ±67.6% for off-site liquid and slurry sample analyses, respectively. This is an analytical precision based on duplicate analyses. A complete summary of the quality assurance/quality control (QA/QC) results are given in Section 9.0.

SECTION 3.0

SITE DESCRIPTION: UPJOHN FINE CHEMICALS DIVISION

The Upjohn Fine Chemicals Division facility tested in this program is located at 410 Sackett Point Road, North Haven, Connecticut. The facility produces a number of specialty chemicals used as intermediates by other Upjohn divisions or sold directly to other end users.

The specialty chemicals are produced in a number of separate batch processing areas. The wastewater from these process units includes water used during the reaction process, water produced by the reaction, water used in washing the final products, and water used in cleaning operations. Waste solids are also associated with the wastewater. One particular batch reactor accounts for a significant fraction of the solids sent to the wastewater treatment area. Current plans call for the installation of a different technology designed to minimize and possibly eliminate this source of solids.

WASTEWATER TREATMENT FACILITY

The wastewater from the batch reactors is highly variable in both flow and composition. Treatment of the wastewater (including the process waste solids) includes a conventional aerated lagoon system. Figure 1 is a schematic diagram of the Upjohn wastewater treatment facility. The unique feature of the facility is the large inflated dome structure over the aerated lagoon basin. The construction of the dome structure is discussed in Section 3.2.

pH Adjustment/Primary Clarification

The wastewater (including the waste solids) from the batch reactors flows into two neutralizer tanks for pH adjustment. As estimated by the plant, the wastewater flowrate averages 20.8 liter per second (330 gpm) with a range of 11.4 to 25 liters per second (180 to 400 gpm). The pH of the raw wastewater may range from <1 to 14. In the neutralizer tanks, caustic or acid is added to maintain the pH in a range of 5 to 9. To reduce odors and volatile organic compound emissions, two 55-gallon drums of activated carbon are used to capture vented hydrocarbon losses from these covered neutralizer tanks.

From the tanks, the wastewater is pumped to the center well of the primary clarifier. This clarifier has a volume of approximately 380,000 liters (100,000 gallons) and provides an average residence time of five hours. The clarifier is covered, and vented emissions are controlled by the 55-gallon carbon drums as described for the neutralizer tanks. The overflow from the clarifier is sent to a trim basin for additional pH adjustment. From the trim basin, the overflow is routed directly into the aerated lagoon.

The underflow from the clarifier is partially (about 33 percent) recycled to the clarifier with the remainder directed to a belt filter for solids dewatering. On the belt filter, the solids are washed with process water before

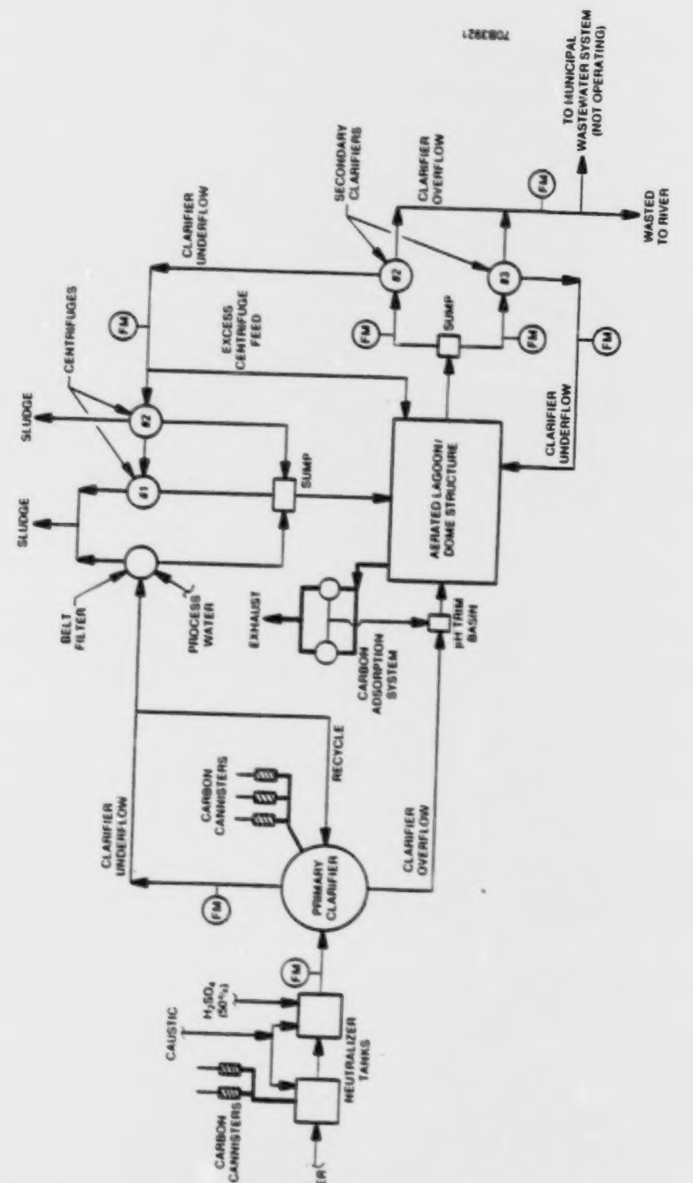

PROCESS WASTEWATER
CARBON CANNISTERS
CAUSTIC
H_2SO_4 (50%)
NEUTRALIZER TANKS
FM
PRIMARY CLARIFIER
FM
CLARIFIER UNDERFLOW
CARBON CANNISTERS
RECYCLE
CLARIFIER OVERFLOW
BELT FILTER
PROCESS WATER
SLUDGE
SLUDGE
#1
#2
CENTRIFUGES
SUMP
EXHAUST
CARBON ADSORPTION SYSTEM
pH TRIM BASIN
AERATED LAGOON/ DOME STRUCTURE
CLARIFIER UNDERFLOW
FM
EXCESS CENTRIFUGE FEED
CLARIFIER UNDERFLOW
FM
SUMP
FM
FM
#2
#3
SECONDARY CLARIFIERS
CLARIFIER OVERFLOW
FM
WASTED TO RIVER
TO MUNICIPAL WASTEWATER SYSTEM (NOT OPERATING)
70B3921

Figure 1. Upjohn Wastewater Treatment Facility

being sent to a solids drying area. The removed wastewater and additional process water are routed to the aerated lagoon through a sump. Also, in this sump, Hydrobac® is added to promote bacterial action in the lagoon. Hydrobac® is a trade name for a freeze-dried specialty bacteria designed to primarily attack aromatic/phenolic materials in the lagoon.

Aerated Lagoon/Dome Structure

The aerated lagoon at Upjohn is approximately 46 meters by 130 meters (150 by 425 feet). The lagoon aeration is performed by two large, 75-hp aerators and 25 smaller 7.5-hp aerators. At least one of the large aerators is operated at all times, while the other large aerator is operated intermittently. Of the 25 smaller aerators, an average of 16 are operating at any one time. The number of aerators in use is usually determined by the dissolved O_2 concentration and maintenance requirements.

The depth of the lagoon is generally held near 1.5 meters (4.8 feet). However, during the test period for this study, the level was substantially lower at 0.55 meter (1.8 feet). The level of the lagoon had been lowered approximately two weeks before the testing. The level was lowered so the aerators could be used to "dig up" the lagoon bottom and thus increase the lagoon volume. The bottom of the lagoon was being lowered at a rate of 0.03 meters (0.1 foot) per month. Of the solids resulting from the lagoon and being wasted at the time of the testing, approximately 75 to 80 percent are solids from the lagoon bottom. The remainder are solids resulting from bacterial action in the lagoon and waste solids from the process wastewater.

Secondary Clarification/Solids Dewatering

From the aerated lagoon, the treated wastewater and resulting solids flow by gravity into a sump and then are pumped to two closed-top secondary clarifiers. In the sump, floc is added to improve the settling characteristics of the solids, and powder activated carbon is added to provide additional hydrocarbon removal from the wastewater as a polishing step and also to promote settling. The treated overflow from the secondary clarifiers is currently routed to a nearby river. Plans call for an expansion of the North Haven municipal wastewater treatment facility and discharge to that facility. The total average overflow rate is approximately 18.9 liters per second (300 gpm).

The underflow from one of the secondary clarifiers is recycled to the aerated lagoon. The underflow from the other clarifier is partially (approximately 20 percent) recycled to the aerated lagoon, while the remainder is used to feed to solids centrifuge. The centrifuges further dewater the sludge solids which are then wasted to the solids drying area. The centrifugate flows by gravity to a sump and is then pumped back to the aerated lagoon.

AERATION LAGOON DOME STRUCTURE

In September 1983, Upjohn consolidated their wastewater treatment operation into one aeration lagoon. To control odors and emissions from the lagoon, the entire 46 by 130 meter lagoon was covered with a PVC coated polyester dome structure. Figure 2 shows the dome structure and attached carbon adsorption system. The dome was manufactured by Air Structures of Tonawanda, New York and is basically an air-tight, inflated bubble structure, approximately 9 meters (30 feet) tall at the highest point. The dome is pressurized by a main blower capable of 9.43 m^3/sec (20,000 cfm) at 374 Pa (1.5 inches of water). The system is also equipped with an emergency fan, a propane-powered auxilliary blower (for use during power failures) and a propane heater (for winter operation). A schematic of the dome inflation system is given in Figure 3.

The integrity of the dome is maintained by steel cables strung over the PVC/polyester material. An air-tight seam is formed at the base of the bubble as shown in Figure 4. The plant has estimated the leakage rate from the dome to be at most 0.14 m^3/sec (300 cfm). Air Structures, Inc., the dome designer, had guaranteed a leakage rate of less than 0.11 m^3/sec (230 cfm). A leak check of the dome seam using a portable hydrocarbon analyzer indicated minimal leakage around the entire structure. Results are shown in Table 1. The PVC/polyester dome is lined with Tedlar® to provide an inert surface to minimize chemical degradation of the dome fabric from contact with hydrocarbon vapors. The Tedlar® also reduces the permeability of the dome fabric to the gases inside.

The air in the dome structure is continuously purged through a fixed-bed carbon adsorption system. The purge rate is approximately 1.4 m^3/sec (3000 cfm), which results in a gas-phase residence time of 9.4 hours in the dome. The high purge rate maintains the atmosphere within the dome at a hydrocarbon level well below the explosive limit and keeps the oxygen content of the atmosphere at an acceptable level. The carbon adsorption system is a two-bed unit which was originally designed for odor control, specifically to remove ortho-chlorophenol. Each bed is 1.2 meters deep by 1.8 meters diameter and contains 3600 kg of activated carbon. Carbon is replaced approximately once per year. The beds were designed to be operated for at least 12 months without regeneration. However, because analytical results from outlet gas samples indicated the carbon beds were being heavily laden with adsorbed hydrocarbons, the beds were modified to be regenerated with steam every 24 hours. Therefore, during current normal operation, one bed is adsorbing and one bed regenerating. The adsorption cycle lasts 24 hours, while the regeneration cycle includes 12 hours of steaming and 12 hours of cooldown. The recovered hydrocarbons and steam condensate from the regeneration cycle flow to the trim basin where they combine with the primary clarifier overflow. From the trim basin, all the fluids flow into the aerated lagoon.

The capital costs of the dome structure and carbon adsorption system are given in Table 2. The total combined cost of the dome and carbon adsorber was

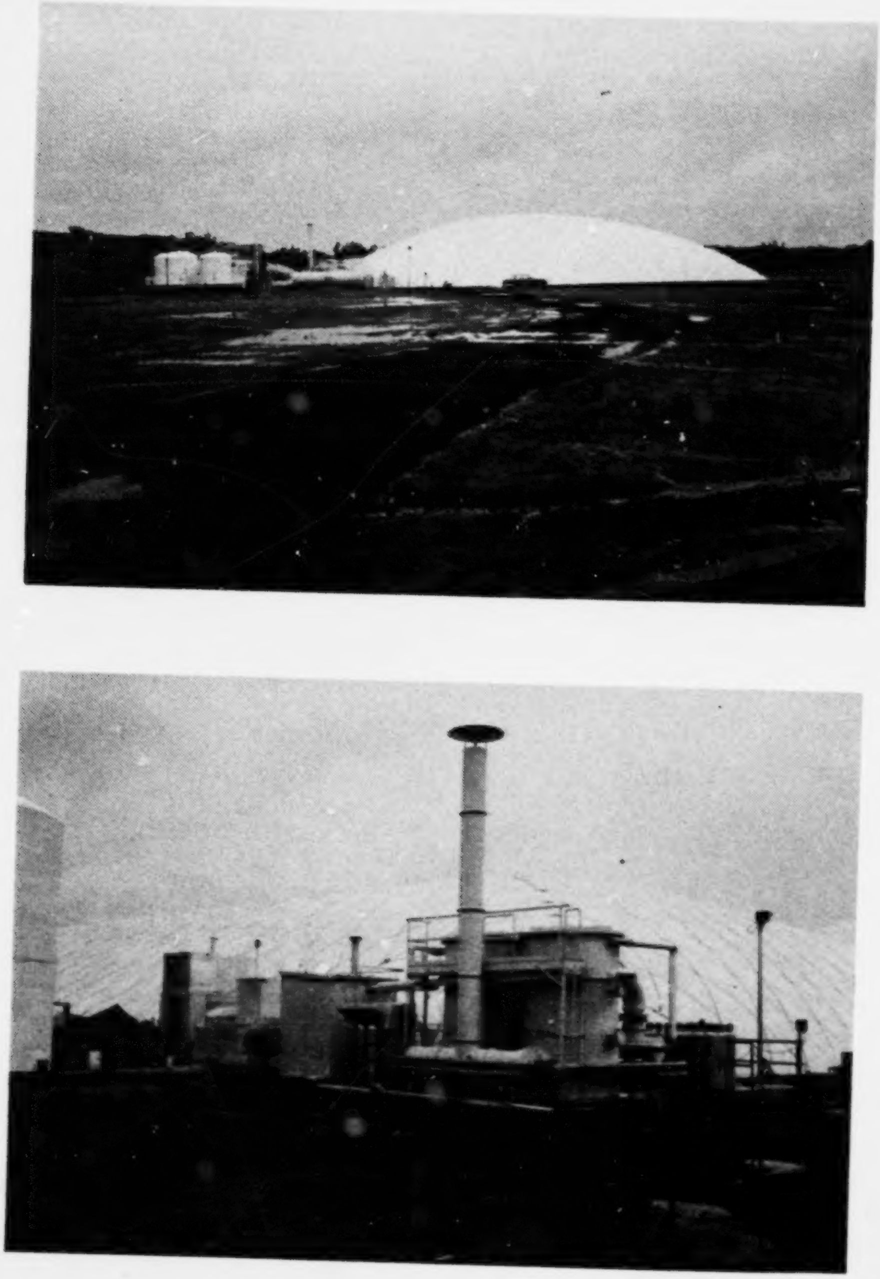
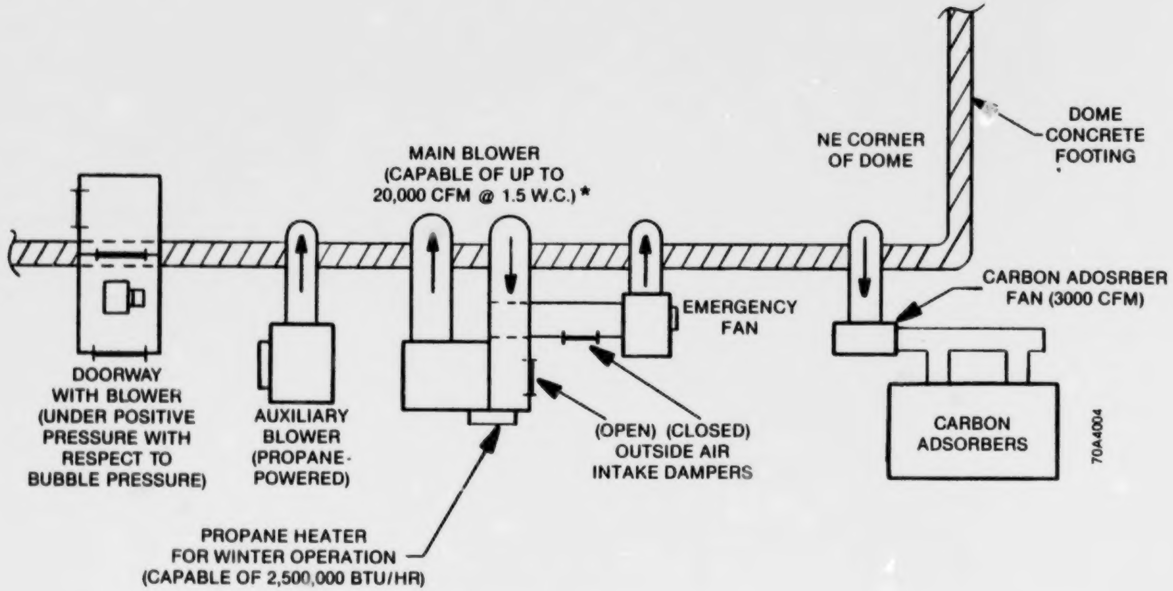


Figure 2. Dome Structure and Carbon Adsorber at Upjohn


MAIN BLOWER
(CAPABLE OF UP TO
20,000 CFM @ 1.5 W.C.)*
NE CORNER
OF DOME
DOME
CONCRETE
FOOTING
CARBON ADOSRBER
FAN (3000 CFM)
EMERGENCY
FAN
DOORWAY
WITH BLOWER
(UNDER POSITIVE
PRESSURE WITH
RESPECT TO
BUBBLE PRESSURE)
AUXILIARY
BLOWER
(PROPANE-
POWERED)
(OPEN) (CLOSED)
OUTSIDE AIR
INTAKE DAMPERS
CARBON
ADSORBERS
70A4004
PROPANE HEATER
FOR WINTER OPERATION
(CAPABLE OF 2,500,000 BTU/HR)

*HAS BEEN SHIMMED AND CURRENT AIR FLOW RATE IS UNKNOWN.

Figure 3. Dome Structure Fan Inflation and Exhaust System

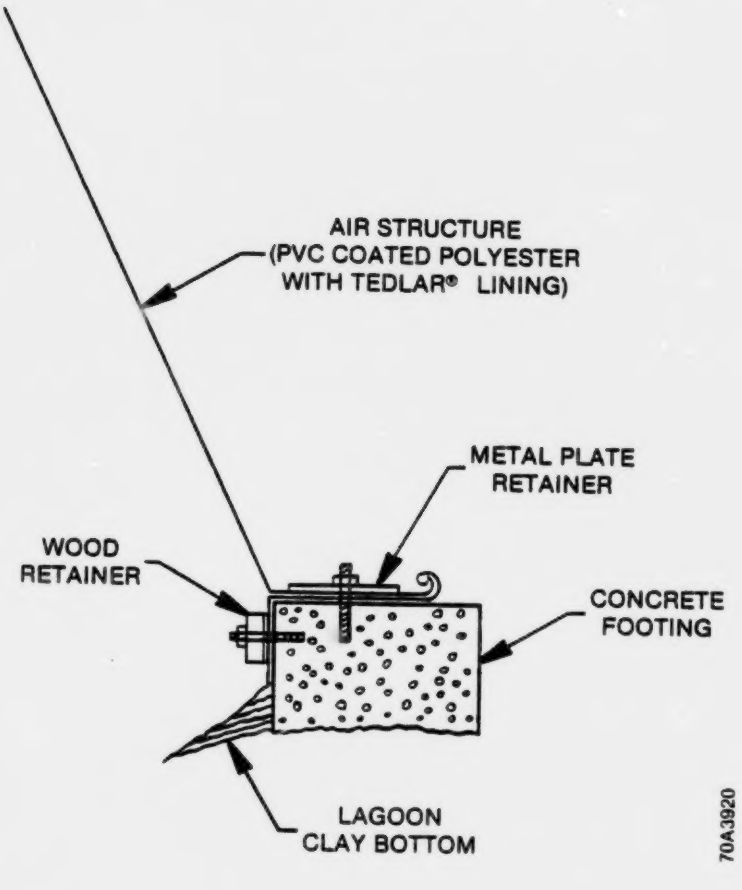

AIR STRUCTURE
(PVC COATED POLYESTER
WITH TEDLAR® LINING)
METAL PLATE
RETAINER
WOOD
RETAINER
CONCRETE
FOOTING
LAGOON
CLAY BOTTOM
70A3920

Figure 4. Dome Seam Construction

TABLE 1. RESULTS OF DOME LEAKAGE MEASUREMENTS

Leak Location	Estimated Flow Rate, l/min (cfm)[a]	Measured Total Hydrocarbon Concentration, ppmv
Perimeter of Escape Hatch	1-2 (0.004-0.007)	30-40
Perimeter of Escape Hatch	10-20 (0.04-0.07)	30-40
At Concrete Footing Near 2nd Clarifier	0.2 (0.0007)	20
At Concrete Footing Near Carbon Adsorber	0.1 (0.0004)	2-3

[a] Visual estimates based on bubbling generated while water was put on leak.

TABLE 2. CAPITAL COSTS OF UPJOHN DOME STRUCTURE AND CARBON ADSORPTION SYSTEM

Dome Structure	Capital Expense (1983 Dollars)
Dome fabric and parts	$300,000
Concrete footings	50,000
Misc. steel	13,000
Erection	55,000[a]
Electrical	80,000
Fill	80,000
Total Dome Cost	$578,000
Carbon Adsorption System	
Carbon adsorber with carbon charge	$ 50,000

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[a] $25,000 for crane rental alone.

$628,000 in 1983. The operating costs for the wastewater treatment facility for the first six months of 1984 are shown in Table 3. Along with the actual costs are estimates of the costs directly associated with the dome and carbon adsorption system. The dome maintenance costs tend to be high because the environment in the dome is hazardous. Upjohn has guidelines for the length of time that maintenance crews are allowed to work within the dome. The allowable working time is determined as a function of temperature (Figure 5). The crews are equipped with self-contained air supply systems. For interior dome temperatures of greater than 38°C (100°F), the allowable working time is less than 30 minutes.

Of the direct expenses, electricity is used primarily to run the blowers. Propane is used 1) to fire the regeneration steam boiler, 2) when the emergency blower is tested, and 3) for dome heating during the winter ice and snow storms. The carbon costs are related to the carbon bed change every three months at a total cost of $12,000. This cost is high because the carbon must be disposed as a hazardous waste. Finally, the equipment rental primarily includes gas cylinders and air compressors used during the dome entry activities.

TABLE 3. UPJOHN WASTEWATER TREATMENT FACILITY OPERATING COSTS

Month (1984)	Maintenance Labor and Materials Actual Total	 Estimated For Dome Structure	Total Direct Expenses Actual Total	 Estimated For Dome Structure
January	$16,988	$13,000	$123,072	$12,250[a]
February	12,157	6,000	96,604	12,250
March	8,462	3,000	142,401	12,250
April	8,430	3,000	189,052	12,250
May	11,864	6,000	145,710	12,250
June	17,073	11,000	87,730	12,250
6 Mo. Total	$74,994	$42,000	$653,430	$73,500

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[a] Based on electricity ($4,500), propane ($150), carbon ($4,000), and rental equipment ($3,600).

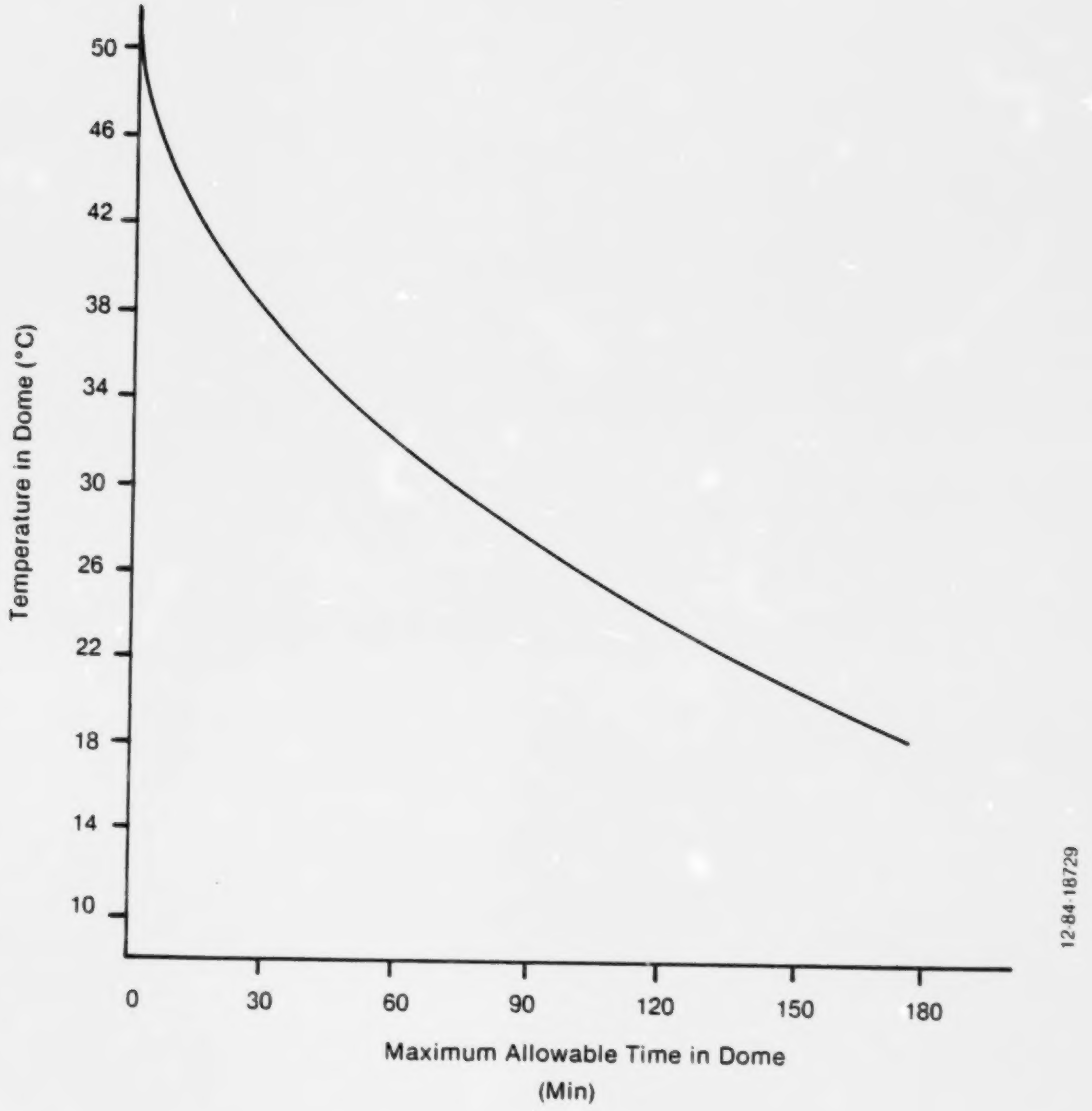

Figure 5. Maximum Allowable Time in Dome for Maintenance Versus Inside Dome Temperature

Source: Upjohn

SECTION 4.0

SAMPLING LOCATIONS

The following section presents the location of sampling activities at the Upjohn facility. Included is a flowsheet showing the emission sources and sampling points, the rationale for the sampling point selection, and any statements necessary to qualify or limit the results.

WASTEWATER TREATMENT FACILITY

Liquid and slurry samples were collected at various locations around the wastewater treatment facility at Upjohn. Figure 6 shows the actual sampling locations. The objective of the sampling was to gather enough data to perform a material balance around the system and assess the VOC emission reduction capability of the dome structure. The inlet to the system was characterized by the primary clarifier overflow and underflow; and the outlets by the treated wastewater, the sludges (from both the belt filter and centrifuges), and the carbon adsorption exhaust (discussed in the next section). Recycle streams within the system are characterized by the secondary clarifier underflow, excess centrifuge feed, and the combined recycle from the belt filter and centrifuges. The recycle to the lagoon from the carbon adsorbers was not sampled but can be assumed to have an insignificant hydrocarbon concentration based upon gas-phase removal data. To eliminate unnecessary duplication in the sampling, it was assumed that both secondary clarifiers operate exactly the same. Both clarifiers are the same volume and diameter and are fed with the same mixed liquor.

Process liquid and slurry flow rates are metered by the flow meters indicated in Figure 6. The plant personnel indicated that all these meters were operational and had been calibrated after installation.

CARBON ADSORPTION SYSTEM

The carbon adsorption system was included in the overall material balance. Both the inlet and exhaust air streams were sampled for VOC content and volumetric flowrate. Figure 6 indicates the sampling locations. The two beds of the carbon system are exhausted through a common stack. The stack provided an ideal location for EPA Methods 1 and 2 stack velocity measurements. The duct diameter is 46 cm (18 inches) and the sample location is more than 8 duct diameters (370 cm) downstream and 2 duct diameters (92 cm) upstream from the nearest disturbances. Therefore, a minimum number of traverse points (in this case, 12) were chosen. There is no reasonable inlet velocity measurement location. Because the system was pressurized and no visible water vapor emissions or hydrocarbon leaks were detected, it was assumed that the inlet gas flow rate to the carbon bed from the dome was equal to the exhaust gas flow rate.

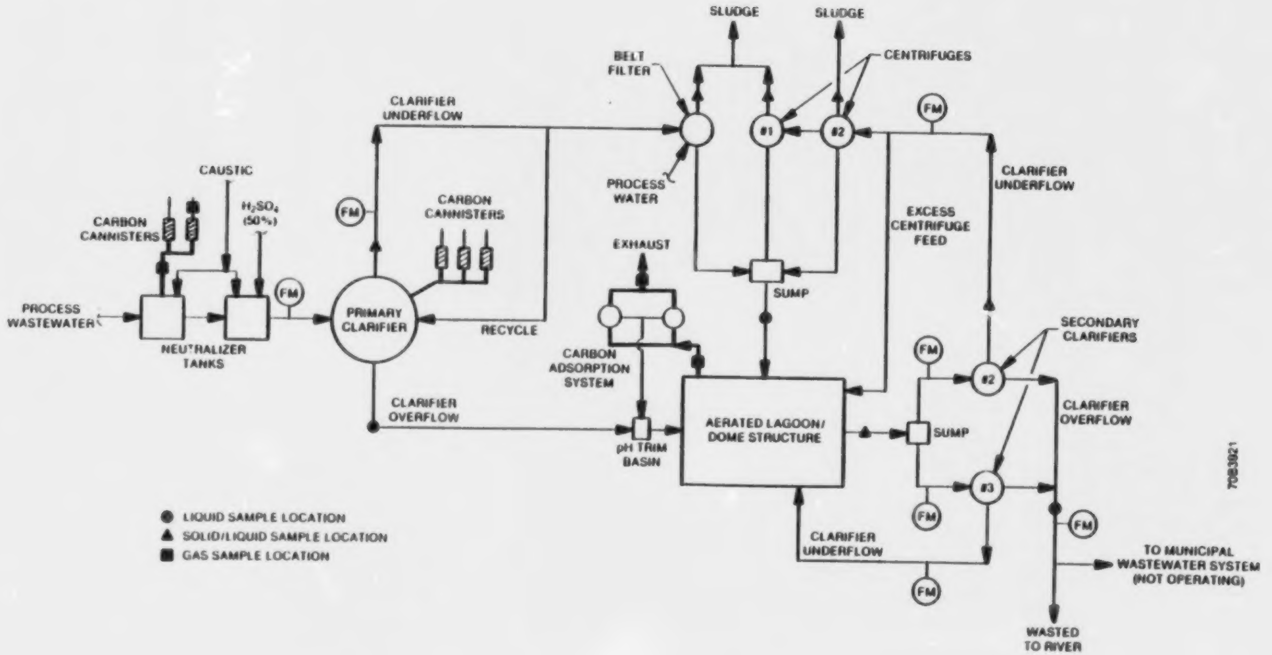
SLUDGE
SLUDGE
BELT FILTER
CENTRIFUGES
CLARIFIER UNDERFLOW
FM
CAUSTIC
H_2SO_4 (50%)
CARBON CANNISTERS
CARBON CANNISTERS
#1
#2
PROCESS WATER
CLARIFIER UNDERFLOW
EXCESS CENTRIFUGE FEED
EXHAUST
PROCESS WASTEWATER
NEUTRALIZER TANKS
PRIMARY CLARIFIER
RECYCLE
SUMP
SECONDARY CLARIFIERS
CARBON ADSORPTION SYSTEM
CLARIFIER OVERFLOW
pH TRIM BASIN
AERATED LAGOON/ DOME STRUCTURE
SUMP
#2
#3
CLARIFIER OVERFLOW
70B3021
● LIQUID SAMPLE LOCATION
▲ SOLID/LIQUID SAMPLE LOCATION
■ GAS SAMPLE LOCATION
CLARIFIER UNDERFLOW
TO MUNICIPAL WASTEWATER SYSTEM (NOT OPERATING)
WASTED TO RIVER

Figure 6. Upjohn Wastewater Treatment Facility Sample Locations

The VOC content of the inlet and exhaust streams was continuously monitored for total hydrocarbon (THC) content and intermittently for organic speciation. The exhaust sample was taken at the same point as the velocity measurement. The inlet sample point was in a common header used to feed the carbon beds. Because of the long residence time in the dome, it was felt that the composition of the inlet sample was relatively stable over short periods of time and was also representative of the air within the dome.

DISPOSABLE CARBON DRUM CONTROLS

Two 55-gallon carbon drums were located on the vent from the neutralizer tanks and three on the vent from the primary clarifier. These drums were used to capture breathing emissions and also for odor control. For this study, only the drums on the neutralizer tanks could be accessed and sampled. The neutralizer tanks are each approximately 75,000 l (20,000 gal) in volume. The drums were attached to the neutralizer vent by 5 cm (2 inch) diameter steel pipes. The same diameter pipe approximately 45 cm (1.5 feet) in length is used as an outlet stack. The flowrates through the drums is extremely low. The sample locations for the drum were located in the pipe approximately 30 cm (1 foot) before the drum entrance and 30 cm (1 foot) after the drum exit.

SECTION 5.0

SAMPLING AND ANALYTICAL PROCEDURES

The sampling and analytical procedures followed for the Upjohn site investigaton are described in this section. The discussion includes gas sample collection, solid and liquid sample collection, and the analytical techniques used on- and off-site. For a more detailed discussion of these topics, see "Field Assessment of Air Emissions and Their Control at Hazardous Waste Facilities; Draft Test Plan for Testing at Upjohn Co., North Haven, CT." (DCN # 84-222-078-00-03).

SAMPLING PROCEDURES

Gas Sampling Procedures

The following gas sampling procedures were used; determination of volumetric flow rate, gas collection for on-site analysis, and gas collection for off-site analysis. Each is discussed in turn below.

Determination of Volumetric Flow Rate--

The total gas flow rate was determined at the outlet of the carbon adsorption system (CAS) twice daily. Procedures described in EPA Reference Method 2 (1) were followed. This method requires determining the cross-sectional area of the duct or stack being tested and measuring the average velocity of the flue gas.

The average gas velocity was calculated from the average gas velocity differential pressure (ΔP), the average flue gas temperature, average wet molecular weight of the flue gas, and the absolute static pressure. The ΔP and temperature profile data were obtained by traversing both diagonals of the stack. The number of sampling points required to measure the average gas velocity was determined using the procedures outlined in EPA Method 1 (2). The number of sampling points and their distance from the duct wall is a function of the proximity of the sampling location to its nearest upstream and downstream flow disturbance.

Temperature and ΔP profile data were measured at each of the sampling points using an S-type pitot tube and K-type thermocouple. A calibrated Magnehelic gauge was attached to the S-type pitot to measure the static pressure within the duct. The moisture content of the gas stream was determined by wet- and dry-bulb temperatures as measured by an in-duct psychrometer.

Gas Collection for On-Site Analysis--

Gas samples were continuously collected from the CAS inlet and outlet for on-site THC analysis using two Byron Instruments Model 401 THC analyzers and gas speciation analysis using a HNU Systems, Inc., Model 301 Gas Chromatograph. The gas extraction systems used at the inlet and outlet sampling locations were identical. Each consisted of a rake-type, in-stack probe, a heated pump, and heat-traced lines leading to the mobile laboratory. The heated sample lines fed directly into the Byron analyzers. A gas sample stream was diverted to the HNU several times daily for speciation.

Gas Collection for Off-Site Analysis--

Gas samples were collected from the CAS inlet and outlet 2-3 times per day in evacuated gas canisters. The samples were analyzed off-site to yield detailed speciation information. The sampling procedure consisted of checking the canister pressure, attaching a one-foot Teflon line to the canister, inserting the line into the sampling port, allowing the canister to fill over approximately a one-minute period, and checking the final canister pressure.

The vents from the neutralizer tanks and primary clarifier included a 55 gallon drum filled with activated charcoal to control VOC emissions. The air flow through these vents was very slow and intermittent in nature. To characterize the removal efficiency and average emissions from these control devices, a two-fold sampling strategy was employed. First, evacuated gas canisters fitted with flow controllers were used to collect inlet and outlet samples integrated over a 16-hour period. Off-site analyses of these samples permitted calculation of the removal efficiency of each vent emission control device. Second, a small (approximately 0.5kg) canister of clean activated charcoal was placed in line upstream bypassing each 55 gallon drum to collect all VOC's being vented over a known length of time. The carbon was extracted off-site to yield the mass/unit time of VOC's reaching the control devices. This information was combined with the removal efficiency data to allow calculation of the average emissions to the atmosphere from each control device, as well as the efficiency of the carbon drums.

Liquid and Sludge Sampling Procedures

Various liquid and sludge samples were collected around the system for later off-site analysis. These data were then used to determine an overall material balance and provide an estimate of the overall effectiveness of the lagoon dome and CAS in controlling VOC emissions. Table 4 lists the streams sampled and the frequency of sampling. Streams thought to be the most variable were sampled the most frequently. All samples were collected in glass containers with Teflon lined caps, appropriately labeled, and stored at approximately 4°C. Sample bottles were filled to minimize any headspace. All samples were grab samples and any compositing occurred subsequently in the analytical laboratories.

ANALYTICAL PROCEDURES

The analytical protocols for this program are divided into two general categories: on-site analyses and off-site analyses. Details for each of these categories are presented in the following subsections.

TABLE 4. IDENTIFICATION OF SAMPLE STREAMS AND SAMPLING FREQUENCY

Sample Stream	Sampling Frequency (per day)
Primary Clarifer Overflow	8
Primary Clarifer Underflow	2
Lagoon Recycle from Solids Handling	4
South Centrifuge Sludge	2
North Centrifuge Sludge	2
Filter Belt Sludge	2
Secondary Clarifier Feed	4
Secondary Clarifier Overflow	2
Secondary Clarifier Underflow	2
Carbon from Packed Bed	1/test

On-Site Analyses

The on-site analyses were limited to gas-phase samples. Gas analyzers were used to monitor the total hydrocarbon (THC) concentration in the inlet and outlet gas streams of the carbon adsorption system at the aerated lagoon, to provide speciation data, and to monitor ambient THC levels. The type of instrument used for each application is described below.

Carbon Adsorption System Gas Phase THC Concentration--

Two Byron Instruments Model 401 THC Analyzers were used as the primary sources of THC data. The instruments were used to semi-continuously monitor the inlet and outlet gas streams of the carbon adsorption system at the aerated lagoon by analyzing a slipstream of the main hydrocarbon-laden air stream. These THC analyzers are essentially dedicated gas chromatographs (GC) fitted with a flame ionziation detector.

In the THC mode, sample is introduced continuously into a sample loop from the sample VOC manifold. At sample injection, the loop contents are flushed into a restrictor column (empty 1/16 in. tubing) and eventually flow into the detector. A complete cycle is completed in one minute. During each cycle, a built-in integrator is first cleared and then allowed to accumulate electrical charge corresponding to the detector response. At the completion of each analysis, this accumulated charge representing the integrated area is available for data recording.

All data from the Byron instruments were automatically captured, stored on disk, and reduced using an Apple® II microcomputer. In addition, the computer recorded date and time of analysis, instrument, analysis type, sampling location, and run number. As a backup to the microcomputer data acquisition system, integrated areas for the instrument were recorded using a strip chart recorder to provide hardcopy records of the analyses.

Gas-Phase Speciation Data--

A HNU Systems, Inc., Model 301 GC was used to provide rudimentary speciation data and total VOC data on samples collected periodically from the primary carbon adsorption system. This GC provides simultaneous flame-ionization detector/photo-ionization detector (FID/PID) detection. The instrument was calibrated with multicomponent standards containing benzene, toluene and chlorobenzene. The instrument was operated isothermally and samples identification was based on retention time. Quantitation was achieved using an external calibration standard. A Hewlett-Packard 3390A integrator was utilized to generate the sample chromatograms and component response data.

Ambient THC Levels--

The Analytical Instrument Development, Inc., Model 580 is a battery powered portable gas analyzer that was used to provide ambient THC data for safety considerations, as well as for ambient surveys and measuring instantaneous gas stream concentrations. The AID 580 contains a GC/PID detector and detects THC over a range of 0-2000 ppm with two sensitivity ranges. The instrument was calibrated with toluene diluted in UHP air.

Off-Site Analyses

Chemical speciation of air samples collected in canisters and of sludge and liquid source samples was performed off-site. Analysis of the various types of samples for C_2 to C_{10} hydrocarbon species took place in three steps: cryogenic concentration, gas chromatographic separation and detection, and data evaluation. Liquid and sludge samples were analyzed using a purge and trap technique modified to integrate with cryogenic concentration. All data are reported as ppmv in dry air (gas samples), mg/l (liquid samples) or ug/g (sludge samples) as quantitated against certified propane and hexane standards.

Air Samples--

To achieve the desired detection levels, hydrocarbon species must be separated from the ambient air matrix and concentrated. This was accomplished by pressurizing the air sample and passing it through a Perma-Pure drying tube to remove water vapor and then through a trap cooled in liquid oxygen. A known amount of sample was desorbed directly onto the analytical columns by heating the traps and backflushing with carrier gas.

All analyses were performed on a Varian 3700 GC. Hydrocarbon species were separated on temperature-programmed, fused silica capillary columns. An FID was used to detect and quantitate hydrocarbon species. A PID was also used to provide additional qualitative information. In addition, a second sample aliquot was resolved on a separate column and analyzed by a Hall Electrolytic Conductivity Detector (HECD) operated in the halogen mode. This provided specific detection of halogenated VOC's which may not otherwise have exhibited adequate response characteristics on the FID/PID.

The FID/PID output from the gas chromatograph was processed with a Varian 401 Chromatographic Data System (CDS). The CDS provided peak areas and retention times. A second data system, Apple II plus microcomputer, was used to identify peaks on the basis of retention times and to compute quantitative results by comparing peak areas with a previously established standard response to toluene. The second data system was also used to perform routine data checks such as resoluton, calibration stability, variance in quality control standards, and blank results.

Liquid Samples--

All liquid samples were analyzed in a purge-and-trap manner. This was accomplished by passing ultra-high purity nitrogen through the sample and trapping the resultant gas mixtures in the cryogenic traps of the analytical system. Sample filtration was not necessary. The analytical procedure followed was then identical to that described above. The volume of sample used depended upon the anticipated concentration of the compounds of interest.

Sludge Samples--

Representative aliquots of sludge samples (sludge and carbon) were extracted with tetraglyme, purged in 5 mL of DI water, cryogenically trapped and then analyzed in the same manner as the gas samples. The tetraglyme extraction method was utilized to determine volatile organic compounds in solid waste samples. The sample of carbon from the carbon bed was analyzed with the same method as the sludges.

Gas Chromatography-Mass Spectrometry (GC/MS) Confirmation--

The identity of the major compounds observed in the air samples analyzed by GC were also determined using a Hewlett-Packard Model 5982 GC/MS system. The GC/MS protocol followed was equivalant to that employed on the GC. One sample was analyzed. This sample was selected from the gas canisters collected on the basis of the component concentrations observed in the GC analyses. The sample was felt to be representative of other air samples.

Weight Percent Solids Determination--

Sludge samples were measured for moisture according to ASTM D2226. The sample was weighed before being placed in a drying oven at 110 ± 5°C. The sample was dried to a constant weight. The percent mositure was calculated from the measured loss of mass.

SECTION 6.0

SAMPLING AND ANALYTICAL RESULTS

As previously mentioned, samples were taken around the wastewater treatment system to perform a material balance and identify the effectiveness of the dome structure in reducing VOC emissions. The resulting data can be separated into three general categories: (1) liquid/solid samples, (2) carbon adsorption system and dome structure air samples, and (3) neutralizer vent samples. The following subsections discuss each of these categories, and include subsections on GC/MS identification and process flowrate measurements.

LIQUID/SOLID SAMPLES

Liquid samples were taken and analyzed from three locations in the wastewater treatment facility: (1) the primary clarifier overflow, (2) the secondary clarifier feed, and (3) the lagoon recycle from the filters and centrifuges. The analyses include total non-methane hydrocarbons (NMHC) and speciation individual components. Only the key individual species will be examined in detail. These species include methylene chloride, 1,2-dichloroethane (1,2-DCE), dioxane, benzene, toluene, chlorobenzene, dichlorobenzene, and chloroform. These components generally comprised 80 percent or greater of the total non-methane hydrocarbon measured in the influent wastewater stream. Complete detailed speciation for each sample is appended to this report.

Primary Clarifier Overflow

A summary of the analytical results for the primary clarifier overflow is shown in Table 5. (Detailed speciation results are given in Appendix I). This stream represents the wastewater that enters the lagoon for treatment. The composition of the stream is highly variable, but consists primarily of 1,2 DCE and benzene with varying amounts of toluene, chlorobenzene and chloroform. The total NMHC concentration in the overflow ranged from 74.1 mg/l to 819 mg/l for all measurements with an average concentration of 248 mg/l. During the August 1984 test period, the average was 185 mg/l.

Test data generated by Upjohn for the same primary clarifier overflow stream is also shown in Table 5. The data agrees well with the test results by Radian. However, Upjohn only measured specific hydrocarbons and did not include 1,2-DCE.

Secondary Clarifier Feed

A summary of the analytical results for the secondary clarifier feed is shown in Table 6. (Detailed speciation results are given in Appendix I). This stream represents the effluent from the activated sludge lagoon. In general, the concentrations of all major species are significantly lower than the concentrations found in the influent wastewater (i.e., primary clarifier

TABLE 5. PRIMARY CLARIFIER OVERFLOW

Date	Data Source	Liquid-Phase Concentration (mg/l)											
		MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
18-Aug-84	R	0.00	42.1	0.00	45.7	40.7	1.37	0.00	0.28	15.9	86.3	44.5	147
18-Aug-84	R	0.00	54.0	0.00	34.9	56.6	1.56	0.00	0.48	13.5	91.6	56.7	162
17-Aug-84	R	0.88	58.2	0.00	87.9	5.38	4.19	0.00	26.7	20.4	93.2	90.2	204
17-Aug-84	R(2)	1.30	35.9	0.00	15.1	8.29	9.97	0.01	0.73	10.7	39.2	55.8	111
16-Aug-84	R	0.00	55.3	0.00	136.0	3.12	1.56	0.00	3.72	33.5	140	61.3	235
16-Aug-84	R(2)	0.00	27.1	0.00	24.5	6.91	2.39	0.00	0.30	12.1	31.5	30.1	74.1
15-Aug-84	R	69.8	84.6	0.00	149.0	8.82	57.9	0.00	17.8	15.2	158	233	406
15-Aug-84	R	0.00	42.5	0.00	50.8	4.55	25.3	0.00	9.17	5.25	98.7	77.1	181
15-Aug-84	R	0.00	44.6	0.00	49.4	3.45	24.4	0.00	1.71	16.4	52.9	70.8	141
17-Jul-84	R	0.00	15.3	0.00	5.62	429	0.83	0.01	0.00	316	484	16.9	819
19-Jun-84	U	0.12			17.1	3.10	1.50	0.11					
18-Jun-84	U	2.90			9.70	5.70	1.80	0.10					
15-Jun-84	U	0.21			39.4	34.2	9.20	1.09					
14-Jun-84	U	0.10			36.7	48.6	1.10	0.21					
13-Jun-84	U	0.23			41.5	35.3	2.60	0.39					
All Ave		5.04	46.0	0.00	49.6	46.2	9.71	0.13	6.09	45.9	128	73.6	248
August Test Ave		8.00	49.4	0.00	65.9	15.3	14.3	.00	6.77	15.9	87.9	79.9	185

R - Radian tests ((2) indicates an average of duplicate samples)
U - Upjohn tests
MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C4 compounds
NMHC - Non-methane hydrocarbon concentration

TABLE 6. SECONDARY CLARIFIER FEED

Date	Data Source	Concentration (mg/l)											
		MeCl	$C_2H_4Cl_2$	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
18-Aug-84	R	0.00	6.15	0.00	0.28	0.00	0.00	0.00	0.17	21.0	2.47	6.81	30.3
17-Aug-84	R	0.00	6.19	0.00	0.00	0.00	0.00	0.00	0.09	17.5	0.35	6.33	25.2
16-Aug-84	R	0.00	0.00	0.00	1.81	0.28	0.00	0.00	0.38	25.2	2.92	2.44	41.2
16-Aug-84	R	0.00	4.46	0.00	0.30	0.85	0.00	0.00	0.18	7.41	32.9	5.01	49.4
20-Jun-84	U	0.00	4.40	7.50	0.00	0.00	0.06	0.05					
30-May-84	U	0.01	5.01	11.9	0.00	0.00	0.00	0.00					
25-Apr-84	U	0.04	3.81	5.11	0.00	0.01	0.01	0.05					
21-Mar-84	U	0.04	0.02	15.4	1.15	0.07	0.01	0.20					
22-Feb-84	U	0.00	0.01	9.69	1.32	1.45	0.09	0.09					
25-Jan-84	U	0.96	0.04	24.7	0.53	1.19	0.15	0.19					
19-Jan-84	U	0.06	0.00	4.77	0.78	2.80	0.48	0.64					
11-Jan-84	U	0.00	0.02	24.6	6.28	9.08	1.55	0.06					
05-Jan-84	U	0.00	0.08	15.2	1.30	1.23	1.13	0.07					
29-Dec-83	U	0.00	0.10	12.2	0.00	0.50	0.10	0.05					
21-Dec-83	U	1.80	0.00	7.00	0.90	1.00	0.80	0.10					
14-Dec-83	U	0.10	0.00	8.90	0.20	0.80	0.30	0.05					
07-Dec-83	U	0.00	0.10	6.20	0.30	0.90	0.00	0.05					
All Ave		0.18	1.79	9.01	0.89	1.19	0.28	0.09	0.21	17.8	9.66	5.15	36.5
August Test Ave		0.00	4.20	0.00	0.60	0.28	0.00	0.00	0.21	17.8	9.66	5.15	36.5

R - Radian tests
U - Upjohn tests
MeCl - Methylene Chloride
$C_2H_4Cl_2$ - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C4 compounds
NMHC - Non-methane hydrocarbon concentration

overflow). Of the major groups of organics (i.e., paraffins, aromatics and halogenated), only the paraffins show little or no reductions.

Upjohn has generated selected speciation data on the same secondary clarifier stream. In general, the results are comparable except for noticeable levels of dioxane found by Upjohn. Radian did not detect dioxane in their samples. No explanation can be given for this result. The only other differences are the low levels of chlorobenzene and dichlorobenzene found by Upjohn but not detected in the Radian samples. In general, Radian did not detect dichlorobenzene in any of their liquid samples.

Lagoon Recycle from the Filters and Centrifuges

Table 7 summarizes the analytical results of the composite liquid filtrate and centrifugate from the solids dewatering area. This liquid consists of wastewater from the influent (primary clarifier) solids dewatering and the effluent (secondary clarifiers) solids dewatering. The composition is similar to that of the secondary clarifier feed. Detailed speciation results are given in Appendix I.

Centrifuge and Filter Bed Sludges

Analyses were also performed on the centrifuge and filter belt sludges. The results of the organic speciation tests are given in Table 8 and the weight percent solids are summarized in Table 9. The organic analyses for the sludges were highly variable. However, in general, the filter bed sludges contain more organic material than the centrifuge sludges. Major components identified in the samples included 1,2-DCE, benzene, toluene, chlorobenzene and dichlorobenzene. Detailed speciation data are given in Appendix J.

CARBON ADSORPTION SYSTEM SAMPLES

During the brief test in July 1984 and the more extensive test in August 1984, the carbon adsorption system inlet and exhaust gas streams were analyzed for TNMHC and for particular organic species. During the August testing, a semicontinuous total hydrocarbon analyzer was used to get real time data on the inlet and exhaust gas streams. Also, the volumetric flowrate of the exhaust gas stream was measured and a grab sample of the bed carbon was taken.

Real-Time Total Hydrocarbon Data

During the August 1984 testing, the carbon adsorber inlet and exhaust gas streams were analyzed semicontinuously for total hydrocarbons and hourly averages are summarized in Table 10. The hourly averages for the outlet THC concentration are missing for late August 15 and early August 16 because readings were off-scale for the recorder being used. The recorder was then adjusted to allow for higher readings. (Examples of the strip chart readings from the THC analyzers are given in Appendix K).

TABLE 7. LAGOON RECYCLE FROM THE FILTER AND CENTRIFUGES

Date	Data Source	Liquid-Phase Concentration (mg/l) MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
18-Aug-84	R	0.00	5.07	0.00	11.0	15.6	0.00	0.00	0.31	15.4	27.1	5.63	48.6
17-Aug-84	R	0.00	4.74	0.00	3.58	1.24	0.00	0.00	0.16	22.0	4.94	4.93	33.3
16-Aug-84	R	0.00	4.33	0.00	4.38	0.90	0.00	0.00	0.10	11.6	5.82	4.44	27.5
Average		0.00	4.71	0.00	6.32	5.91	0.00	0.00	0.19	16.3	12.6	5.00	36.5

R - Radian tests
MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C4 compounds
NMHC - Non-methane hydrocarbon concentration

TABLE 8. SUMMARY OF SLUDGE ANALYSES

	Total Sludge Concentration (ug/g)											
Date	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
Centrifuge #1 Sludge												
18-Aug-84	0.00	7.47	0.00	4.74	0.00	5.46	1.78	1.10	83.7	13.3	34.1	131
16-Aug-84	0.00	3.22	0.00	0.00	0.00	1.85	0.71	0.15	158	115	8.48	364
Centrifuge #2 Sludge												
18-Aug-84	0.00	4.46	0.00	2.38	0.00	3.08	0.76	1.19	14.9	3.38	12.7	31.0
16-Aug-84	0.00	2.73	0.00	0.91	0.00	0.00	0.67	1.03	39.3	70.4	8.28	137
Filter Belt Sludge												
18-Aug-84	0.00	62.7	0.00	202	306	149	21.4	4.99	1390	552	279	2320
16-Aug-84	0.87	51.4	0.00	60.0	24.7	118	4.77	1.65	97.2	249	194	603
Primary Clarifier Sludge												
17-Aug-84	2.60	0.10	0.00	14.4	8.50	10.9	0.10	1.00	6.20	25.6	30.3	65.9

MeCl - Methylene Chloride

C2H4Cl2 - 1,2-Dichloroethane

CBZ - Chlorobenzene

DCBZ - Dichlorobenzene

Paraffins - Primarily C7 through C10+ compounds

NMHC - Non-methane hydrocarbon concentration

TABLE 9. SUMMARY OF SLUDGE WEIGHT PERCENT SOLIDS TESTING

Sample No.	Sample Location	Sample Date	Wet Wt (g)	Dry Wt (g)	Tare Wt (g)	Wt % Solids
U016	Primary Clarifier Underflow	8/15	108.56	70.54	65.08	12.6
U040	Secondary Clarifier Feed	8/16	109.89	69.04	68.13	2.2
U047	South Centrifuge	8/16	79.59	67.43	65.34	14.7
U048	North Centrifuge	8/16	98.10	65.84	62.19	10.2
U049	Filter Belt	8/16	99.01	73.80	68.95	16.1
U051	Secondary Clarifier Underflow	8/16	104.55	66.79	65.31	3.8
U105	South Centrifuge	8/18	82.50	68.19	65.74	14.6
U106	North Centrifuge	8/18	96.51	69.67	66.61	10.2
U107	Filter Belt	8/18	102.00	73.99	68.35	16.8
U113	Secondary Clarifier Feed	8/18	102.08	69.43	68.70	2.2

TABLE 10. CARBON ADSORBER TOTAL HYDROCARBON DATA[a]

Date	Interval	Average Inlet THC Conc (ppmvc)	Average Outlet THC Conc (ppmvc)
8/15/84	1911-1959	752	737
	2000-2059	723	727
	2100-2142	685	730
	2143-2159	677	--[b]
	2200-2259	676	--
	2300-2359	726	--
8/16/84	0000-0059	903	--
	0100-0128	1101	--
	0347-0359	1144	--
	0400-0459	1080	--
	0500-0559	963	--
	0600-0659	839	--
	0700-0759	761	--
	0800-0837	701	--
	0837-0859	681	770
	0900-0959	652	737
	1000-1059	619	741
	1100-1117	598	740
	1800-1859	1119	914
	1900-1934	1168	966
	2200-2259	1681	1217
	2300-2359	1609	1293
8/17/84	0000-0059	1490	1254
	0100-0159	1358	1207
	0200-0259	1230	1155
	0300-0359	1108	1122
	0400-0459	968	1033
	0500-0559	887	960
	0600-0659	809	933
	0700-0759	757	917
	0800-0859	693	848
	0900-0914	699	1395
	0915-0959	657	798
	1000-1032	661	810

TABLE 10. CARBON ADSORBER TOTAL HYDROCARBON DATA (Continued)

Date	Interval	Average Inlet THC Conc (ppmvc)	Average Outlet THC Conc (ppmvc)
8/17/84	1700-1759	1429	1355
	1800-1859	1753	1584
	1900-1959	1971	1867
	2000-2048	2153	2066
8/18/84	0300-0359	1759	2043
	0400-0459	1562	1812
	0500-0559	1431	1643
	0600-0659	1413	1541
	0700-0759	1472	1200
	0800-1859	1657	1489
	0900-0952	1797	1663
	1016-1054	1820	1768
	1607-1659	1421	1705
	1700-1759	1425	1727
	1800-1859	1341	1594
	1900-1959	1235	1490
	2000-2059	1120	1381
	2100-2159	1050	1318
	2200-2259	988	1232
	2300-2359	933	1155
8/19/84	0000-0059	878	1088
	0100-0159	834	1030
	0200-0259	810	993
	0300-0359	780	970
	0400-0459	806	959
	0500-0559	834	949
	0600-0659	849	991
	0700-0759	850	1029
	0800-0859	811	851

[a] Data Generated by Byron Model 401 analyzer.

[b] Off-scale results (i.e. greater than 1000 ppmvc). Then adjusted to allow readings up to 2500 ppmvc.

The results from the real time tests indicate that there are gradual increases and decreases with time in the total hydrocarbon concentration in the gas stream. The concentrations ranged from 600 to 2150 ppmvc (or, assuming an average C_5 compound, 125 to 430 ppmv). In general, comparable increases and decreases in the inlet gas stream were also seen in the exhaust gas stream.

During normal operation of the carbon adsorber, each bed processes gas for 24 hours before regeneration. The bed switching usually occurs at 6:00 a.m. However, on August 17, 1984, the switch occurred at 9:00 a.m. The hourly average during the switch indicated a slight rise in the exhaust gas concentration. After this brief excursion, the exhaust appears to be no different in composition from the previous on-line bed.

Carbon Adsorber Inlet and Exhaust Detailed Organic Analyses

The specie data for the inlet and outlet of the carbon adsorption bed are shown in Table 11 and 12, respectively. Included with the Radian outlet test data are data generated by Upjohn in previous testing. (The detailed analytical results for the carbon adsorption system gas canister samples are given in Appendix L). The data generated by the on-site HNU systems Model 301 GC were used as a qualitative field check of the gas-phase data and also as a backup to the carbon canister analyses. Because the canister results were adequate for this study, the HNU GC results were not interpreted and therefore are not presented in this report.

The carbon adsorber inlet and outlet gas analyses indicate that a majority of the organics present in the air stream are halogenated. In particular, a large amount of 1,2-DCE is seen in the gas stream. Other major components include benzene, toluene, and chlorobenzene. These data, in general, agree with most of the previous Upjohn test results, although data generated prior to April 1984 showed little or no 1,2-DCE in the exhaust gas.

The volumetric flowrate was measured five times in the carbon adsorber outlet duct during the August 1984 testing. The gas velocity ranged from 8.5 to 9.0 meters per second (28.0 to 29.6 feet per second) with an average of 8.78 meters per second (28.8 feet per second). The raw field data and flow rate calculations are given in Appendix M.

Additional gas-phase speciation testing was performed within the dome itself. Samples were taken by inserting sample lines into the dome at hatch locations in the Southeast (SE) and Southwest (SW) corner of the dome structure. The results of those tests are presented in Table 13 and agree well with the carbon adsorber inlet speciation results for the same day. (A complete listing of the analytical results for the dome NMHC measurements is given in Appendix Q).

Volumetric Flowrate Test and Activated Carbon Sample

A sample of carbon from the carbon adsorber bed was obtained from a freshly regenerated bed and analyzed for adsorbed hydrocarbons. In general,

TABLE 11. CARBON ADSORBER INLET TEST RESULTS

	Gas-Phase Concentration (ppmv)											
Date	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
18-Aug-84	4.3	240	0.0	21.2	92.1	0.4	1.2	81.5	153	117	331	607
17-Aug-84	4.0	204	0.0	26.0	5.7	13.2	0.6	27.4	63.2	33.1	251	348
17-Aug-84	5.1	172	0.0	4.5	5.1	3.6	0.5	16.4	10.4	11.2	200	222
17-Jul-84	0.0	770	0.0	2.4	181	76.8	0.0	0.0	45.6	303	848	1360
All Ave	3.4	347	0.0	13.5	71.0	23.5	0.6	31.3	68.1	116	408	634
August Tes	4.5	205	0.0	17.2	34.3	5.7	0.8	41.8	75.5	53.8	261	392

MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C7 compounds
NMHC - Non-methane hydrocarbon concentration

TABLE 12. CARBON ADSORBER OUTLET TEST RESULTS

		Gas-Phase Concentration (ppmv)											
Date	Data Source	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
19-Aug-84	R	0.1	15.3	0.0	9.5	24.0	26.3	2.7	0.6	63.4	43.5	46.1	158
18-Aug-84	R	2.1	355	0.0	24.8	54.1	8.8	0.1	34.0	167	89.8	409	698
17-Aug-84	R	4.2	205	0.0	22.8	7.5	13.3	0.8	25.9	49.8	32.2	251	334
17-Aug-84	R(2)	5.1	231	0.0	15.1	19.6	6.6	0.2	16.1	13.0	38.6	264	317
17-Jul-84	R	0.0	770	0.0	2.6	119	112	0.0	0.0	50.3	129	1070	1480
20-Jun-84	U	0.4	93.4	0.8	26.0	9.7	10.8	1.1					
01-Jun-84	U	0.1	211	1.0	29.1	14.3	5.9	4.6					
27-Apr-84	U	0.1	100	1.6	9.6	18.1	7.2	0.1					
22-Mar-84	U	0.3	4.7	0.5	60.2	64.2	4.9	0.2					
23-Feb-84	U	3.9	0.4	8.7	8.9	62.6	12.0	23.0					
27-Jan-84	U	0.0	0.0	0.4	18.5	59.9	23.8	5.3					
19-Jan-84	U	0.0	0.0	0.0	17.1	72.0	28.2	6.0					
13-Jan-84	U	0.6	0.0	0.5	23.5	56.2	36.6	3.4					
06-Jan-84	U	0.0	0.0	0.3	26.6	54.2	32.7	4.6					
29-Dec-83	U	1.8	0.3	0.4	2.7	30.8	6.0	0.7					
21-Dec-83	U	5.8	0.1	2.0	9.5	38.6	28.0	4.0					
16-Dec-83	U	0.2	0.1	0.9	5.4	35.1	14.6	4.1					
09-Dec-83	U	6.2	0.1	1.7	6.2	28.8	2.1	3.2					
All Ave		1.7	110	1.0	17.7	42.7	21.1	3.6	15.3	68.7	66.6	408	597
August Test Ave		3.8	264	0.0	20.9	27.1	9.6	0.4	25.3	76.6	53.5	308	450

R - Radian tests ((2) indicates an average of a duplicate sample)
U - Upjohn tests
MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C7 compounds
NMHC - Non-methane hydrocarbon concentration

TABLE 13. DOME INTERIOR TEST RESULTS

		Gas-Phase Concentration (ppmv)											
Date	Location	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
17-Jul-84	SE Corner	0.0	680	0.0	2.0	151	67.0	0.0	0.0	22.1	239	756	1170
17-Jul-84	SW Corner	0.0	650	0.0	2.3	166	61.8	0.0	0.0	22.0	277	712	1190

MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C9 through C10+ compounds
NMHC - Non-methane hydrocarbon concentration

the carbon was wet indicating complete saturation with water (from the steam regeneration). The analysis indicated a total adsorbed hydrocarbon weight of 3.28 wt % of the carbon (on a wet carbon basis). Primary components on the carbon included 1,2-dichloroethane, chlorobenzene, dichlorobenzene, benzene, toluene, and numerous heavy paraffins, olefins and aromatics. (A complete listing of the analysis is given in Appendix N). The carbon analysis showed that some of the major species were adsorbing to the carbon, however, because the moisture content was so high, the capacity of the bed was reduced to a very small amount.

NEUTRALIZER VENT SAMPLES

The 55-gallon carbon adsorption drums on the neutralizer tank vents (see Figure 1) were tested to assess the NMHC removal efficiency and also to measure the total NMHC vented. Table 14 shows the results of the removal efficiency testing for the primary organic compounds identified in this study. (A complete listing of the efficiency testing analyses is given in Appendix O). A 450 gram sample of clean carbon was used to capture all the vent emissions during a 24-hour period. The adsorbed organics are very similar to the organics measured in the efficiency testing. (A complete listing of the carbon sample analysis is also given in Appendix P).

GC-MS IDENTIFICATION

A gas chromatograpy/mass spectrometry (GC-MS) technique was used to corroborate the identification of the major species found in this study. Table 15 lists the major species and the identification by both GC/FID/PID/ HECD and GC-MS. The data indicate good agreement, particularly for the major components of 1,2-DCE, benzene, toluene, and chlorobenzene.

PROCESS FLOWRATE DATA

For this study, the liquid and slurry process flowrates were based entirely on data from plant process flowmeters and plant estimates. A complete listing of the flowrate data is shown in Table 16. These data are used to perform material balances in Section 7.

The streams with flowmeters are identified in Figure 1. Hourly flow rate data are given in Appendix A. The flowrates for the metered streams shown in Table 16 are based on an average of the hourly data for the test period of August 16, 17 and 18, 1984. The plant staff indicated that these flowmeters had been calibrated, but no data were presented to support this. Also, the wastewater effluent flow to the river is monitored by a magnetic flowmeter. This information, however, was not available during the test period.

TABLE 14. TEST RESULTS FOR CARBON CANISTER ON NEUTRALIZER VENT

		Gas-Phase Concentration (ppmv)											
Date	Location	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
19-Aug-84	Inlet	0.0	17.9	0.0	12.4	12.4	0.5	0.0	0.1	8.7	25.1	19.3	53.1
19-Aug-84	Outlet	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	23.5	24.7

MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C7 (inlet) and C3-C5 (outlet) compounds
NMHC - Non-methane hydrocarbon concentration

TABLE 15. SPECIE IDENTIFICATION BY GC/FID/PID/HECD AND BY GC/MS[a]

Major Specie [b]	Specie Identified GC/FID/PID/HECD	Specie Identified GC/MS	GC/MS Confidence Level[c]
Paraffin			
Cyclohexane	✓		2
Isoheptane	✓	✓	2
3-Methylhexane	✓	✓	2
n-Heptane	✓	✓	2
Methylcyclohexane	✓	✓	2
2,3,-dimethylpentane	✓	✓	3
1,2-dimethylcyclopentane	-d	✓	2
1,1-dimethylcyclopentane	-d	✓	3
1,3-dimethylcyclopentane	-d	✓	2
Olefin			
C_6H_{12} alkene		✓	3
Aromatics			
Benzene	✓	✓	2
Toluene	✓	✓	2
m/p-Xylene	✓	✓	2
o-Xylene	✓	✓	2
1,2,4-Trimethylbenzene	✓		
C_9-Aromatic	✓		
Halogens			
Chloromethane	✓		
Methylene Chloride	✓		
Chloroform	✓	✓	2
1,2-Dichloroethane	✓	✓	2
Chlorobenzene	✓	✓	2

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[a] Based on analysis of gas sample U4100.

[b] A major specie is defined as an individual compound measured at one (1) ppmv or greater by either analytical technique.

[c] Confidence levels are: 1) Identification based on comparison to standard, 2) computer library match of high probability, and 3) tentative, manual interpretation.

[d] No GC/FID/PCD/HECD standard for comparison, however, a large C_7 alkane peak was identified.

TABLE 16. PROCESS FLOW STREAM DATA

Stream ID - Process	Flowrate During Test,[a] l/min Average	Range	Measurement Technique
Process Wastewater	1080	400-1500	Doppler Flowmeter
Underflow Primary Clarifier	238	150-350	Doppler Flowmeter
Primary Clarifier Recycle	38	38-75	Estimated by Plant
Process Water - Belt Press	38		Estimated by Plant
Clarifier #2 Feed	863	825-1100	Doppler Flowmeter
Clarifier # 2 Underflow	365	275-375	Doppler Flowmeter
Excess Sludge Feed	57	0-170	Estimated by Plant
Clarifier # 3 Feed	795	600-1100	Doppler Flowmeter
Clarifier #3 Overflow	Not available		Magnetic Flowmeter
Clarifier # 3 Underflow	568	475-750	Doppler Flowmeter

[a] August 16-18

SECTION 7

MEASURED EMISSION RATES AND EFFECTIVENESS OF VOC CONTROLS

The effectiveness of the wastewater treatment facility in reducing and controlling non-methane hydrocarbon compounds (NMHC) can be assessed from the data generated during the test program. The VOC emission and biodegradation rates are calculated from material balances around the treatment facility. (Examples of the material balance calculations are given in Appendix C). Furthermore, the effectiveness of VOC control is calculated for the aerated lagoon, the dome structure, the carbon adsorption beds, and finally the 55-gallon drums of carbon.

MASS BALANCE AND OVERALL NMHC EMISSION RATES

Approximate mass balances can be performed around the entire wastewater treatment facility and around the aerated lagoon/dome. These mass balances are only approximate because of the variability of influent hydrocarbon concentrations and the limited number of samples that were collected. The data used for the balances are averages of all speciation and flowrate data generated during the test period of August 16, 17 and 18, 1984. The only exception to this is the speciation data for the primary clarifier overflow. Here, the average organic concentration is based on data generated from samples taken from August 15 through August 18. This exception was made because the variability of the influent wastewater (i.e., primary clarifier overflow) is more adequately characterized with a larger number of samples. Also, because the lagoon has a long residence time (approximately 2 days), the influent on August 15 influences the pond and effluent compositions during the August 16 through 18 time frame.

Mass Balance Around the Entire Wastewater Treatment Facility

The influent streams to the wastewater treatment facility consist of the feed to the primary clarifier, process water to the belt filter and steam used to regenerate the carbon in the carbon adsorption system. These latter two streams contain negligible quantities of NMHC. The effluent streams consist of the carbon adsorber exhaust, the filter belt sludge, the centrifuge sludge and the effluent wastewater. Additional potential losses of NMHC from the system include gaseous emissions from the primary and secondary clarifiers and from the centrifuges and filter presses. However, these potential losses were assumed to not be significant.

The influent NMHC flowrate to the wastewater treatment facility is estimated by the NMHC in the feed to the primary clarifier. The feed includes the wastewater sent to the aerated lagoon and any sludge and wastewater that is sent directly to the sludge pile from the belt filter (see Figure 1). The feed rate is 1090 kg/min, and the average NMHC concentration is 390 mg/l. Therefore, the influent NMHC rate is calculated at 0.42 kg/min.

The NMHC effluent emission rate in the carbon adsorber exhaust is calculated from the exhaust gas rate and the average outlet NMHC concentration. The exhaust flowrate was measured at 1.4 m^3/sec (3000 cfm) based on the average of five velocity traverses made during the test (Appendix M). The average NMHC concentration as measured by the canister GC/FID/PID/HECD technique is 450 ppmv, on a wet basis. The resulting NMHC emission rate is 0.14 kg/min.

The filter belt sludge consists of untreated wastewater solids. Therefore, the average NMHC loading on the sludge is relatively high and measured at 1460 ug/g. The flowrate of this stream is estimated to be 165 kg/min (260 tons/day). The resulting NMHC effluent rate for the belt filter sludge is 0.24 kg/min.

The effluent centrifuge sludge results from the dewatering of the secondary clarifier underflow. By material balance, the total effluent sludge rate is estimated at 97 kg/min (150 tons/day). The measured average NMHC content of the wet sludge is 140 ug/g. Therefore, the calculated average NMHC effluent rate for the wasted sludge is 0.014 kg/min.

The effluent wastewater flowrate is calculated from a water balance around the wastewater treatment facility. The average wastewater flowrate is estimated at 720 kg/min (190 gpm). The average NMHC in the effluent wastewater is 37 mg/l, resulting in an average NMHC effluent rate of 0.026 kg/min.

A summary of the overall NMHC mass balance is given in Table 17. As shown in the table, the major NMHC effluent points are the filter belt sludge and the dome exhaust. The effluent wastewater and centrifuge sludge account for approximately 6 and 4 percent, respectively, of the total effluent NMHC. Complete detailed calculations of the mass balances are given in Appendix C.

Also presented in Table 17 are the estimated relative standard error (i.e., relative standard deviation of the mean) for each term in the overall NMHC balance. The standard errors were calculated using a Monte Carlo simulation (Appendix D). The large relative standard errors for some of the terms in Table 17 reflects the large uncertainties associated with several of the measured parameters (e.g., NMHC concentrations in sludges).

Direct measurement of biological oxidation in the aerated lagoon was beyond the scope of this program. However, an indirect estimate of biodegradation is the difference between the influent and effluent NMHC mass flows in the overall balance (i.e., balance closure). The closure of the overall NMHC balance was good, and indicated slightly more NMHC in the effluent streams than in the influent stream. This tends to indicate that no biodegradation is occurring. However, the 95% confidence interval for balance closure was 83 to 142 percent. The large width of this interval reflects the uncertainties in several of the measured parameters. Since this interval includes balance closure, i.e., 100%, it is impossible to conclude (with 95% confidence) that biological oxidation is or is not occurring.

TABLE 17. SUMMARY OF MASS BALANCE RESULTS AROUND THE WASTEWATER TREATMENT FACILITY (Based on Averages of the Data)

Influent or Effluent		NMHC Flow[a] (kg/min)	% of Influent
Influent			
Primary Clarifier Feed		0.42 ± 36%	100
	Total	0.42 ± 36%	100
Effluent			
Carbon Adsorber Exhaust		0.14 ± 27%	33
Filter Belt Sludge		0.24 ± 59%	57
Centrifuge Sludge		0.016± 44%	4
Wastewater		0.026± 15%	6
	Total	0.42 ± 35%	100

[a] ± Values are relative standard errors calculated by Monte Carlo simulation. This simulation indicates 95 percent confidence interval for balance closure to be 83 to 142%.

Mass Balance Around the Aerated Lagoon/Dome

The aerated lagoon is designed to biologically degrade organic compounds. As stated previously, the direct measurement of the biological oxidation is difficult and was beyond the scope of this program. However, an indirect estimate of the biodegradation can be made by performing an approximate NMHC material balance around the lagoon.

An analysis similar to the one described in the previous section was performed for the influent and effluent streams to the aerated lagoon/dome impoundment. The influent streams consist of the primary clarifier overflow, the carbon adsorber condensate, clarifier Δ3 underflow, excess centrifuge feed and the filtrate/centrifugate. The effluent streams included the dome exhaust, Δ2 and Δ3 clarifier feed, and, estimated by difference, the biodegradation. A summary of the results of the balances is given in Table 18 and the detailed calculations are presented in Appendix C.

The majority (84 percent) of the influent NMHC comes from the primary clarifier overflow. The carbon adsorber condensate is assumed to contribute negligible amounts of NMHC, while the clarifier Δ3 underflow, filtrate/centrifugate, and excess centrifuge feed contribute varying amounts of NMHC ranging from 1 to 10 percent of the total influent.

More than half of the influent NMHC is emitted with the dome exhaust to the carbon adsorber. (It should be noted that the dome exhaust is the effluent stream for the lagoon balance, while the carbon adsorber exhaust is the effluent stream for the overall wastewater treatment system balance). The biodegradation, which is estimated by difference, accounts for over 13 percent of the influent NMHC to the aerated lagoon.

An uncertainty analysis was also performed on the lagoon balance. The results of this analysis, in terms of relative standard error for each term, are presented in Table 18. This uncertainty analysis also indicated that the 95 percent confidence interval for the biodegradation term (calculated by difference) is -0.071 to 0.127 kg/min. Since this interval includes zero, it indicates that the actual estimation of the biological oxidation by difference cannot be made with 95 percent confidence. Uncertainty calculations are present in Appendix D.

Because the testing included speciation of the NMHC, the ultimate fate of specific compound groups can be estimated. The test results indicate that paraffins, aromatics and halogens account for the vast majority of the species measured. Table 19 presents the estimated ultimate fate of each of those groups. Once again, the biological oxidation values are estimated by difference.

Examination of Table 19 leads to the following observations. First, the majority of the halogens appear to leave the system as vapor in the dome exhaust. All other streams show much lower halogen effluent rates. Second,

TABLE 18. SUMMARY OF MASS BALANCE RESULTS AROUND LAGOON
(Based on Averages of the Data)

Influent or Effluent	NMHC Flow[a] (kg/min)	% of Influent
Influent		
Primary Clarifier Overflow	0.177 ± 17%	84
Carbon Adsorber Condensate	0.0	0
Clarifier #3 Underflow	0.021 ± 15%	10
Excess Centrifuge Feed	0.002 ± 18%	1
Filtrate/Centrifugate	0.011 ± 18%	5
Total	0.211 ± 15%	100
Effluent		
Dome Exhaust to Carbon Adsorber	0.123 ± 30%	58
#2 and #3 Clarifier Feed	0.060 ± 15%	28
Biodegradation[b]	0.028 ± 172%	13
Total	0.211 ± 15%	100

[a] ± values are relative standard errors calculated by Monte Carlo simulation.

[b] By difference. 95% confidence interval is -0.071 to 0.127 kg/min.

TABLE 19. ULTIMATE FATE OF ORGANIC GROUPS

	Paraffins		Aromatics		Halogens[b]		NMHC	
	kg/min	% of Total NMHC	kg/min	% of Total NMHC	kg/min	% of Total NMHC	kg/min	% of Total NMHC
Primary Clarifier Overflow	0.015 ± 17%	7.1	0.084 ± 16%	39.8	0.076 ± 27%	36.0	0.177 ± 17%	83.9
Carbon Adsorber Condensate	0	0	0	0	0	0	0	0
Clarifier #3 Underflow	0.010 ± 22%	4.7	0.006 ± 71%	2.8	0.003 ± 19%	1.4	0.021 ± 15%	10.0
Excess Centrifuge Feed	0.001 ± 24%	0.5	0.0005± 72%	0.2	0.0003 ± 21%	0.1	0.002 ± 18%	0.9
Filtrate/Centrifugate	0.005 ± 18%	2.4	0.004 ± 56%	1.9	0.002 ± 7%	0.9	0.011 ± 18%	5.2
Total Influent	0.031 ± 12%	14.7	0.095 ± 15%	45.0	0.081 ± 25%	38.4	0.211 ± 15%	100.0
Dome Exhaust to Carbon Adsorber	0.024 ± 53%	11.4	0.017 ± 58%	8.1	0.082 ± 15%	38.9	0.123 ± 30%	58.3
#2 and #3 Clarifier Feed	0.029 ± 22%	13.7	0.016 ± 72%	7.6	0.008 ± 19%	3.8	0.060 ± 15%	28.4
Biodegradation[c]	-0.022 ± 62%	-10.4	0.062 ± 30%	29.4	-0.009 ± 209%	-4.3	0.028 ± 172%	13.3
Total Effluent	0.031 ± 12%	14.7	0.095 ± 15%	45.0	0.081 ± 29%	38.4	0.211 ± 15%	100.0

[a] ± Values are relative standard errors calculated by Monte Carlo simulation.

[b] Halogenated Organics.

[c] By difference. 95 percent confidence intervals are estimated as follows:
Paraffins: -0.048 to 0.002 kg/min
Aromatics: 0.025 to 0.096 kg/min
Halogens: -0.056 to 0.036 kg/min
NMHC: -0.071 to 0.127 kg/min

the majority of the aromatics appear to be lost through biodegradation. Finally, paraffins appear to be generated in the lagoon (possibly as a result of biodegradation of aromatics). However, the 95 percent confidence interval estimates presented in Table 19 for the biodegradation term indicate that the biological oxidation of paraffins, halogens, and NMHC cannot be determined with 95 percent confidence.

OVERALL EFFECTIVENESS OF THE AERATED LAGOON

The overall effectiveness of the aerated lagoon in reducing the concentration of NMHC in the wastewater is calculated by comparing the influent NMHC concentration to the effluent NMHC concentration. For the Radian test data, the influent stream is characterized by the primary clarifier overflow, while the effluent is characterized by the secondary clarifier feed. The results of this comparision are shown in Table 20. The removal efficiencies for methylene chloride, 1,2-dichloroethane, benzene, toluene, and chlorobenzene are very high, (i.e. 91 to 100 percent) and agree well with data reported by Upjohn. The overall total NMHC removal efficiency is lower at 80 percent primarily due to the negligible removal of paraffins. In fact, the data indicate an increase in paraffin concentration possibly due to degradation products from the biological oxidation of aromatics in the lagoon.

CONTROL EFFECTIVENESS OF THE DOME STRUCTURE

The control effectiveness of the dome structure is a measure of the dome's ability to contain gas-phase NMHC emissions from the aerated lagoon. During the test, the control effectiveness could not be quantified. The plant indicated the dome had a relatively good seal and estimated the total leakage at 0.14 m^3/sec (300 cfm). Radian personnel performed a crude leak check of the dome. The perimeter of the dome was surveyed with a portable hydrocarbon analyzer. Water was also used to roughly quantify any detected leak by spraying the liquid along the dome seam and observing any bubbles. (A summary of the results of these tests are shown in Table 1). Relatively few small leaks were found indicating that the leak rate may be much less than 0.14 m^3/sec. Therefore, for the mass balance calculations it is assumed the dome leakage is negligible and NMHC capture is essentially 100 percent.

CARBON ADSORPTION BED CONTROL EFFECTIVENESS

The carbon adsorption bed control performance was measured by two techniques. First, semi-continuous analyzers were used to analyze both the inlet and outlet of the carbon bed. These analyzers made total hydrocarbon measurements every minute. Second, canister grab samples of the inlet and outlet air streams were taken at least once a day. These samples were analyzed off-site for specific speciation of the NMHC gases. The results of the semi-continuous analyses (Table 21) and the canister sample analyses (Table 22) are basically the same and indicate that the beds are not removing the major species in the dome exhaust gas stream. This result is not unexpected for at least two reasons. First, the beds were not originally designed for bulk removal of NMHC from the air stream. Rather, the beds were designed for odor control (for which they appear to be currently effective) and specifically for removal

TABLE 20. SOLVENT SPECIE REMOVAL AT UPJOHN

	Average Influent[a] (mg/L)	Average Effluent[b] (mg/L)	Average Removal[c]	% Removal Reported By Upjohn[d]
Methylene chloride	8.0 ± 7.7	0.0	100 ± 0%	98.2
1,2-Dichloroethane	49.4 ± 5.4	4.2 ± 1.4	91 ± 3%	94.1
Benzene	65.9 ± 16.0	0.60± 0.41	99 ± 1%	99.98
Toluene	15.3 ± 6.5	0.28± 0.20	98 ± 2%	99.8
Chlorobenzene	14.3 ± 6.3	0	100 ± 0%	97.6
Chloroform	6.77± 3.2	0.21± 0.06	97 ± 2%	NR
Paraffins	15.9 ± 2.7	17.8 ± 3.8	-12 ± 30%	
Aromatics	87.9 ± 14.4	9.7 ± 7.8	89 ± 9%	
Halogens	79.9 ± 20.0	5.2 ± 1.0	93 ± 2%	
NMHC	185 ± 32.1	36.5 ± 5.5	80 ± 5%	

[a] Average and relative error for 9 determinations (see Table 5).
[b] Average and relative error for 4 determinations (see Table 6).
[c] Average and relative error expressed as a percent.
[d] Source: Larry Joffe, Upjohn (8/15/84) (data from June 1984 removal study.)
NR = not reported

TABLE 21. CARBON ADSORBER TOTAL HYDROCARBON REMOVAL EFFICIENCY

Date	Interval	Average Inlet THC Conc (ppmc)	Average Outlet THC Conc (ppmc)	Average Bed Removal Efficiency (%)
8/15/84	1911-1959	752	737	-23.8
	2000-2059	723	727	-.6
	2100-2142	685	730	-6.6
	2143-2159	677	--[a]	
	2200-2259	676	--	
	2300-2359	726	--	
8/16/84	0000-0059	903	--	
	0100-0128	1101	--	
	0347-0359	1144	--	
	0400-0459	1080	--	
	0500-0559	963	--	
	0600-0659	839	--	
	0700-0759	761	--	
	0800-0837	701	--	
	0837-0859	681	770	-13.1
	0900-0959	652	737	-13.1
	1000-1059	619	741	-19.8
	1100-1117	598	740	-23.8
	1800-1859	1119	914	18.3
	1900-1934	1168	966	17.2
	2200-2259	1681	1217	27.6
	2300-2359	1609	1293	19.6
8/17/84	0000-0059	1490	1254	15.8
	0100-0159	1358	1207	11.1
	0200-0259	1230	1155	6
	0300-0359	1108	1122	-1.3
	0400-0459	968	1033	-6.8
	0500-0559	887	960	-8.3
	0600-0659	809	933	-15.4
	0700-0759	757	917	-21.2
	0800-0859	693	848	-22.4
	0900-0914	699	1395	-99.6
	0915-0959	657	798	-21.5
	1000-1032	661	810	-22.6

(continued)

TABLE 21. UPJOHN CARBON ADSORBER TOTAL HYDROCARBON REMOVAL EFFICIENCY (Continued)

Date	Interval	Average Inlet THC Conc (ppmc)	Average Outlet THC Conc (ppmc)	Average Bed Removal Efficiency (%)
8/17/84	1700-1759	1429	1355	5.1
	1800-1859	1753	1584	9.6
	1900-1959	1971	1867	5.2
	2000-2048	2153	2066	4
8/18/84	0300-0359	1759	2043	-16.2
	0400-0459	1562	1812	-16.1
	0500-0559	1431	1643	-14.9
	0600-0659	1413	1541	-9.1
	0700-0759	1472	1200	18.4
	0800-1859	1657	1489	10.1
	0900-0952	1797	1663	7.4
	1016-1054	1820	1768	2.8
	1607-1659	1421	1705	-20
	1700-1759	1425	1727	-21.2
	1800-1859	1341	1594	-18.9
	1900-1959	1235	1490	-20.7
	2000-2059	1120	1381	-23.4
	2100-2159	1050	1318	-25.6
	2200-2259	988	1232	-24.7
	2300-2359	933	1155	-23.8
8/19/84	0000-0059	878	1088	-24
	0100-0159	834	1030	-23.6
	0200-0259	810	993	-22.6
	0300-0359	780	970	-24.4
	0400-0459	806	959	-19
	0500-0559	834	949	-13.8
	0600-0659	849	991	-16.8
	0700-0759	850	1029	-21.1
	0800-0859	811	851	-5

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[a] Off-scale readings.

TABLE 22. CARBON ADSORBER REMOVAL EFFICIENCY FOR SPECIFIC SPECIES

Date	Gas-Phase Concentration (ppmv)											
	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
18-Aug-84 Inlet	4.3	240	0.0	21.2	92.1	0.4	1.2	81.5	153	117	331	607
18-Aug-84 Outlet	2.1	355	0.0	24.8	54.1	8.8	0.1	34.0	167	89.8	409	698
Removal Eff (%)	51.2	-47.9	NA	-17.0	41.3	-2100	91.7	58.3	-9.2	23.2	-23.6	-15.0
17-Aug-84 Inlet	4.0	204	0.0	26.0	5.7	13.2	0.6	27.4	63.2	33.1	251	348
17-Aug-84 Outlet	4.2	205	0.0	22.8	7.5	13.3	0.8	25.9	49.8	32.2	251	334
Removal Eff (%)	-5.0	-0.5	NA	12.3	-31.6	-0.8	-33.3	5.5	21.2	2.7	0.0	4.0
17-Aug-84 Inlet	5.1	172	0.0	4.5	5.1	3.6	0.5	16.4	10.4	11.2	200	222
17-Aug-84 Outlet	5.1	231	0.0	15.1	19.6	6.6	0.2	16.1	13.0	38.6	264	317
Removal Eff (%)	0.0	-34.3	NA	-236	-284	-83.3	60.0	1.8	-25.0	-245	-32.0	-42.8
17-Jul-84 Inlet	0.0	770	0.0	2.4	181	76.8	0.0	0.0	45.6	303	848	1360
17-Jul-84 Outlet	0.0	770	0.0	2.6	119	112	0.0	0.0	50.3	217	1070	1480
Removal Eff (%)	NA	0.0	NA	-8.3	34.3	-45.8	NA	NA	-10.3	28.4	-26.2	-8.8

MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C7 compounds
NMHC - Non-methane hydrocarbon concentration
NA - Not applicable

of orthochlorophenol. Second, the extremely high (saturated) water vapor content in the exhaust gas stream interferes with the removal capabilities of the activated carbon. Generally, activated carbons are used only on gas streams with a relative humidity of 50 percent or less.

Alternatives to the existing carbon adsorption system include incineration and carbon adsorption with dehumidification of the inlet gas stream. Incineration can be performed with a thermal or catalytic incineration device. Due to the high chlorinated organic content and variability in the dome exhaust stream, thermal incineration appears to be the best option. For a 3000 cfm exhaust stream, the capital cost of a typical thermal incineration device is approximately the same as a carbon adsorption unit. The operating costs will be higher due to the energy costs for incineration. During the winter months, the higher costs may be somewhat offset by heat recovery used to heat the air in the dome. Currently, direct-fired propane burners are used to heat the dome to prevent ice formation and possible dome collapse.

A properly designed thermal incineration system should achieve 95 percent destruction of the inlet organics. If the waste exhaust is considered hazardous, the control efficiency for the thermal incineration may be required to be significantly higher (i.e., 99%+). In this case, the capital costs may increase due to design changes needed for high efficiency. Also, the operating costs will escalate due to higher incineration temperatures required for high efficiency operation. Actual cost estimates will be site-specific for these hazardous waste-type incinerators.

One draw-back with the incineration technique is the formation of HCl with the combustion of the chlorinated organics. Several states regulate HCl emissions. If the facility is out of compliance, a control device such as a wet scrubber will be required to reduce the emissions. This scrubber system will be relatively expensive because the dilute HCl scrubber liquor is highly corrosive. Plastic and nickel alloys have been used in most applications.

The carbon adsorption control system should be more efficient if the dome exhaust is dehumidified. With the high degree of aeration and long gas-phase residence time in the dome, the exhaust gas stream is saturated with water. As previously mentioned, most systems operate with gas streams at 50 percent relative humidity or less. To achieve this with the aerated lagoon/dome exhaust, a gas cooler/dehumidifer is required. This can consist of an air-to-air heat exchanger or a liquid-to-air heat exchanger. At the Upjohn site, the dome exhaust should be cooled from the 32°C (90°F) to 15°C (60°F). The gas would then be reheated to 32°C (90°F) before entering the carbon beds. This type of system may achieve 95 percent overall reduction of the organic gases in the dome exhaust. The capital cost for the dehumidification device may be as high as 50 percent of the total carbon adsorption system. Operating costs will also be higher than for the carbon adsorber alone. One drawback is the handling of the recovered organics. The current system at Upjohn allows any recovered solvent to recycle to the aerated lagoon. The data generated during the recent tests indicate that only aromatic compounds are significantly decreased in the aerated lagoon. Therefore, recycling is likely to result in higher dissolved organic loadings in the dome and higher concentrations of NMHC in the effluent wastewater. The NMHC in the effluent will probably result in additional air emissions once they are discharged to the river. A more realistic situation would involve the recovery of the solvent for further use. In this case, the additional cost of distillation is incurred. The capital cost of a distillation system may be equal to or greater than the carbon adsorption system by itself. However, operating costs may actually decrease depending on the credits given for the recovered organics. An alternative to distillation is off-site disposal of the recovered organics which will result in an increase in the operating cost of the carbon adsorption system.

CONTROL EFFECTIVENESS OF THE CARBON CANISTERS ON THE NEUTRALIZER VENT

Fifty-five gallon drums of activated carbon are used to control odors and NMHC emissions from the neutralizer tanks and the primary clarifier (see Figure 1). Gas canister samples were taken on the inlet and outlet side of the carbon drum on the neutralizer tank to measure the VOC reduction of the drum. Table 23 presents the test results which indicate a high degree of removal for specific components (i.e. 1.2-dichloroethane, benzene, toluene, chlorobenzene and chloroform) and a relatively high degree of removal for specific compound groups (except possibly halogens). In addition, a test was performed to measure the NMHC emission rate from the neutralizer tank. The measured emission rate was $8.7X10^{-8}$ kg/min ($1.15X10^{-5}$ lb/hr). (See Appendix C for the mass emission rate calculation).

TABLE 23. NEUTRALIZER VENT CARBON DRUM REMOVAL EFFICIENCY RESULTS

		Gas-Phase Concentration (ppmv)											
Date	Location	MeCl	C2H4Cl2	Dioxane	Benzene	Toluene	CBZ	DCBZ	Chloroform	Paraffin	Aromatic	Halogen	NMHC
19-Aug-84	Inlet	0.0	17.9	0.0	12.4	12.4	0.5	0.0	0.1	8.7	25.1	19.3	53.1
19-Aug-84	Outlet	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	23.5	24.7
Removal eff. (%)		NA	100	NA	100	100	100	NA	100	90.8	99.2	-21.8	53.5

MeCl - Methylene Chloride
C2H4Cl2 - 1,2-Dichloroethane
CBZ - Chlorobenzene
DCBZ - Dichlorobenzene
Paraffins - Primarily C7 (inlet) and C3-C5 (outlet) compounds
NMHC - Non-methane hydrocarbon concentration

SECTION 8

PREDICTED EMISSION RATES

PREDICTED AERATED SURFACE IMPOUNDMENT EMISSIONS

The primary predictive model for estimating volatile organic emissions from aerated surface impoundments is the Thibodeaux-Parker-Heck model (3). A complete listing of the model is given in Appendix D. Basically, this model develops liquid-and gas-phase mass transfer coefficients for both the aerated (turbulent) surface and non-aerated (quiescent) surface. Then, the mass transfer coefficients are used to directly calculate emission rates.

Although the Thibodeaux-Parker-Heck model is meant to predict emissions from an aerated lagoon, the Upjohn aerated lagoon is an inappropriate site to verify the model. The Thibodeaux model is based on a much deeper impoundment than the 0.5 meters (1.8 feet) at Upjohn. Also, the model is based on a well-mixed lagoon, and no measurements were taken to verify if the Upjohn lagoon was well mixed. The aerators likely lose their aeration ability and consequently desorbing ability in shallow water. Also because there is effectively no wind in the dome basin, the air can become super saturated in spots which results in negative emissions.

However, to demonstrate the use of the model, the emission rates were predicted for the major gas-phase constituents at Upjohn (toluene, benzene, and 1,2-dichloroethane). Inputs to the model include the physical properties shown in Table 24. Other inputs include process characteristics such as total aeration horsepower, aeration oxygen transfer rate, aerator impellor dimensions and pond dimensions. The model also accounts for the reduction in emission driving force due to the high concentrations of organic compounds in the gas phase in the dome. The results of the modeling are presented in Table 25. In general, for the specific components, the model does not provide a good prediction of the measured component emission rates. Two of the three rates are predicted to be negative which is unrealistic. The calculated mass transfer coefficients shown in Table 25 are nearly identical which indicates that the differences in the predicted emission rates are due to differences in the driving force. Because the gas-phase concentrations are high in the dome, there is a reduced driving force from the liquid-phase hydrocarbon components.

The same analysis was performed for the major compound groups at Upjohn (i.e. paraffins, aromatics, and halogens with similar results). Estimated physical properties for these groups are shown in Table 26. These values are based on weighted averages of the physical properties of the major individual compounds in the respective groups. The predicted emission rates are compared to the measured rates in Table 27. In this case, predicted emission rates for paraffins and aromatics are significantly higher than the measured emission rates and the halogens are once again negative.

TABLE 24. PHYSICAL PROPERTIES OF SELECTED ORGANICS

	Toluene (MW = 92.1)		Benzene (MW = 78.0)		1,2-Dichloroethane (MW = 99.0)	
	25°C	33°C	25°C	33°C	25°C	33°C
Solubility (part/100 parts)	0.0535	0.060	0.178	0.19	0.83	0.90
Density (g/cm^3)	0.866	0.860	0.884	0.877	1.252	1.242
Vapor pressure (mmHg)	28	42.5	95	136	86	115
Henry's Law Constant $\frac{\text{atm-m}^3}{\text{gmole}}$	$6.34\text{x}10^{-3}$[a]	$8.58\text{X}10^{-3}$	$5.48\text{X}10^{-3}$	$7.34\text{X}10^{-3}$[b]	$1.34\text{X}10^{-3}$[c]	$1.66\text{X}10^{-3}$
Diffusivity in Water (cm^2/sec)	$9.1\text{X}10^{-6}$	$9.34\text{X}10^{-6}$[d]	$1.03\text{X}10^{-5}$	$1.06\text{X}10^{-5}$[d]	$9.88\text{X}10^{-6}$	$1.01\text{X}10^{-5}$[d]
Diffusivity in Air (cm^2/sec)	0.0849	0.0883[e]	0.0932	0.0970[e]	0.0907	0.0944[e]

[a] Reported at $5.93\text{x}10^{-3}$ (1)
[b] Reported at $5.55\text{X}10^{-3}$ (1)
[c] Reported at $1.10\text{X}10^{-3}$ (1)
[d] Based on ratio of $(306/298)^{1.0}$
[e] Based on ratio of $(306/298)^{1.5}$

TABLE 25. PREDICTED AND MEASURED EMISSION RATES FOR TOLUENE, BENZENE AND 1,2-DICHLOROETHANE

	Liquid Phase conc., mg/l	Gas Phase conc., ppmv	Mass Transfer Coefficient[a], gmole/cm^2-sec		Predicted Emission Rate[b,c], kg/min	Measured Emission Rate[c], kg/min
			K_N	K_T		
Toluene	0.28	34.3	4.45×10^{-6}	9.70×10^{-3}	(-0.030) ± 410%	0.011 ± 58%
Benzene	0.60	17.2	5.03×10^{-6}	10.3×10^{-3}	0.135 ± 91%	0.005 ± 58%
1,2-Dichloroethane	4.2	205	4.61×10^{-6}	10.1×10^{-3}	(-2.68) ± 33%	0.064 ± 15%

[a] Estimated by the Thibodeaux-Parker-Heck model.

[b] See Appendix D for input data.

[c] ± values are relative standard errors.

K_N = Overall mass transfer coefficient for the quiescent zone.

K_T = Overall mass transfer coefficient for the turbulent zone.

TABLE 26. AVERAGE PHYSICAL PROPERTIES OF MAJOR ORGANIC GROUPS

	Paraffins (MW = 62.9)		Aromatics (MW = 83.0)		Halogens (MW = 103.7)	
	25°C	33°C	25°C	33°C	25°C	33°C
Solubility (part/100 parts)	0.017	0.019	0.139	0.150	0.692	0.750
Density (g/cm^3)	0.590	0.585	0.880	0.874	1.243	1.233
Vapor Pressure (mmHg)	1764	2300	73.9	95	81.8	105
Henry's Law Constant $\frac{\text{atm-m}^3}{\text{gmole}}$	0.859	1.00	5.81X10^{-3}	6.92X10^{-3}	1.61X10^{-3}	1.91X10^{-3}
Diffusivity in Water (cm^2/sec)	9.38X10^{-6}	9.63X10^{-6}	10.0X10^{-6}	10.3X10^{-6}	9.65X10^{-6}	9.91X10^{-6}
Diffusivity in Air (cm^2/sec)	0.085	0.088	0.0899	0.0935	0.0900	0.0936

TABLE 27. PREDICTED AND MEASURED EMISSION RATES FOR PARAFFINS, AROMATICS AND HALOGENS

	Liquid Phase conc., mg/l	Gas Phase conc., ppmv	Mass Transfer Coefficient[a], gmole/cm^2-sec		Predicted Emission Rate[b,c], kg/min	Measured Emission Rate[c], kg/min
			K_N	K_T		
Paraffins	17.8	75.5	4.63×10^{-6}	9.85×10^{-3}	5.56 ± 32%	0.024 ± 53%
Aromatics	9.66	53.8	4.89×10^{-6}	10.2×10^{-3}	2.93 ± 82%	0.017 ± 58%
Halogens	5.15	261	4.57×10^{-6}	9.98×10^{-3}	(-2.65) ± 35%	0.082 ± 15%

[a] Estimated by the Thibodeaux-Parker-Heck model.
[b] See Appendix D for input data.
[c] ± values are relative standard errors.
K_N = Overall mass transfer coefficient for the quiescent zone.
K_T = Overall mass transfer coefficient for the turbulent zone.

Although the Thibodeaux-Parker-Heck model may give comparative results under certain situations, the model is very sensitive to variables that are difficult to quantitatively measure. These include the correction factor for O_2 transfer in wastewater, the oxygen transfer rating of the surface aerator, and the fraction of the surface area affected by aeration.

CONTROL EFFECTIVENESS OF AERATED LAGOON

If the Thibodeaux model is applicable, the effectiveness of the dome can be estimated by comparing the VOC control with and without the dome. From the estimated air emission rate for the case without the dome, a comparison can be made for various control levels of the aerated lagoon. The control levels which can be considered are: (1) the aerated lagoon without a dome, (2) the aerated dome with the existing dome and control device, and (3) the aerated lagoon with an alternate control device. The alternate control device can be a thermal incinerator operating at 95 percent control efficiency.

One potential problem with the above analysis concerns the emissions associated with the wastewater effluent. With the dome, very high, liquid-phase NMHC concentrations will be present because the gas-phase organic partial pressure is high, much higher than in the normal atmosphere. Therefore, when this liquid is discharged to an environment that does not have the high gas-phase concentration, degassing can occur. The extent of the degassing is unknown, but with negligible biodegradation, the percent degassed could be high.

The cost effectiveness of the dome can be estimated by comparing the operating costs of the dome to the expected emission reductions. The baseline can with no dome will have zero operating costs. The current system with poor VOC removal efficiency in the carbon bed will have a relatively high cost effectiveness. If a more efficient control device, such as the thermal incinerator is added, the cost effectiveness will be dramatically improved.

HWANG PREDICTIVE MODEL FOR BIOLOGICAL OXIDATION

A further refinement of the Thibodeaux-Parker-Heck model for aerated surface impoundments is the addition of a term for biological oxidation. Hwang has suggested a model based on the first-order Grau constant for biological oxidation (3). Ideally, the model is used when the aerated impoundment outlet NMHC concentration is unknown. Also, the model is designed for two situations (1) when adsorption of NMHC on the sludge solids is significant and (2) when adsorption is minimal. Because the Thibodeaux model is not applicable for the Upjohn facility, the addition of the biodegradation term is not relevant.

PREDICTIVE FIXED ROOF TANK EMISSION MODELS

The predictive model used to estimate NMHC breathing loss emissions from the fixed roof tanks was developed by the American Petroleum Institute (API) and further refined by TRW, Inc. (3). (Only breathing losses are considered because the tanks at Upjohn are fixed level). The model predicts the yearly breathing loss emission rate from the molecular weight of the vapor, true vapor pressure of the bulk NMHC liquid, tank diameter, average height of the vapor space, and the average ambient diurnal temperature changes. It also requires correction factors for color of tank and diameter of the tank.

As an example, the neutralizer tank at Upjohn was modeled to predict emissions (see Appendix Q). The predicted yearly emission rate is 0.47 kg or 5.4×10^{-5} kg/hr. The measured emission rate from the same tank is 5.22×10^{-6} kg/hr. This indicates relatively good agreement between the model and the measured behavior.

SECTION 9

DATA QUALITY

For any measurement effort, there always exists some degree of uncertainty associated with the data due to inherent limitations of the measurement system. Usefulness of the measurement data is dependent upon the degree to which the magnitude of this uncertainty is known. The test approach used to measure volatile organic carbon (VOC) emission rates from Upjohn's covered stabilization pond and carbon adsorption system incorporated a comprehensive quality assurance/quality control (QA/QC) program. The objectives of the QA/QC program were twofold: 1) to control data quality within acceptable limits, and 2) to provide information for assessing data quality.

Quality control procedures include empirical aspects such as technical competence, good laboratory practice, standard operating procedures, as well as suitable facilities and equipment, and documentation. These aspects of quality control are typically assessed by an independent QA systems audit. There was no systems audit conducted at the Upjohn facility. Activities used to quantitatively assess data quality in terms of precision and accuracy include analysis of duplicate, control, and blank samples, and duplicate analyses. In this program, data quality was assessed through the use of:

- duplicate analyses,
- control sample analyses,
- blank analyses, and
- drift checks.

The remainder of this section contains (1) a summary and conclusion; (2) a discussion of the procedures used to assess data quality for a Varian 3700 GC system; (3) a description of procedures for two Byron 401 THC analyzers; and a discussion of the use of an HNU Model 301 GC.

SUMMARY AND CONCLUSIONS

The primary emphasis of this program was to measure pollutant concentrations in gas, liquid, and slurry samples. The QA/QC program focused upon these analyses. The results of this program indicate that the measurement data should generally be of adequate quality to fulfill the program objectives. Table 28 presents a summary of QA objectives and observed results.

Replicability, based on duplicate analyses, was especially good for the Byron 401 THC analyzers. Repeatability based on drift checks was also acceptable. Replicability for the Varian 3700 GC system was acceptable with the exception of the sludge analyses. Repeatability on the Varian systems was acceptable based on drift checks.

Accuracy was acceptable for both Byron and Varian systems. Bias was indicated in the recovery of some chlorinated hydrocarbons by the Varian GC.

TABLE 28. SUMMARY OF QA OBJECTIVES AND RESULTS

Method	Objective			Observed		
	Precision[a]	Accuracy[b]	Data Capture[c]	Precision[a]	Accuracy[b]	Data Capture[c]
Varian 3700 (GC/FID-PID/HECD analysis)	30%	±50%	90%	38%	±29%	100%
Byron 401 (Real-time analysis using THC analyzer)	20%	±20%	90%	4.88%	± 8.2%	93%

[a] Coefficient of variation based on duplicate determinations.

[b] Average % difference between true and measured values.

[c] Valid data percentage of total tests conducted.

VARIAN 3700 GC SYSTEM

A Varian 3700 GC system was used off-site for analysis of canister, liquid, and slurry samples. The instrument was equipped with dual columns. The effluent from one column was split to two detectors, a flame ionization detector (FID) and a photoionization detector (PID). The second column was interfaced with a Hall electrolytic conductivity detector (HECD).

Internal quality control activities for this system included analyses of control standards, system blanks, and duplicate analyses. Duplicate analyses provided the mechanism for assessing analytical variability. Control sample analyses provided the means of assessing precision and accuracy. Acceptance criteria for the Varian 3700 GC were:

- CV ≤30% for replicate determination, and
- ±50% recovery of control samples.

Table 29 presents a summary of analytical precision based on duplicate analyses. The average of the coefficients of variation (CV) for the gaseous, sludge, and liquid phases were 21.2%, 67.6% and 25.0%, respectively. Four of the five classes of hydrocarbons quantified in the sludge analyses had CVs greater than the program objective of 30%. In gaseous samples, analyses of total halogenated hydrocarbons exceeded 30% CV; and in liquid samples, analyses of paraffins exceeded 30% CV.

Table 30 presents a summary of analytical precision and accuracy based on daily analysis of EPA QC samples. The mean recovery of nine control compounds over the five days using HECD was 129% with a pooled CV based on recovery of 12.3%. The mean recovery of 3 control compounds analyzed with PID/FID over five days was 89% with a pooled CV of 18.4%. Seventy-five percent of the standard compounds were recovered within the acceptance criteria of ±50%. Mean recovery at the 95% confidence level did not include the true value (100%) for 67% of the compounds analyzed. This represents statistically significant bias. High recovery of chlorobenzene may have been due to the instability of the chlorobenzene standard which is thought to condense on the walls of the storage bottle. This would result in a lower true value and higher percent recovery. The high recovery of dichloromethane and 1,1,2,2-tetrachloroethane could have resulted from using average response factors (RFs). Individual RFs for these compounds were not determined.

Daily drift checks were performed for the Varian 3700 system. Results are summarized in Table 31. Single point RFs were calculated daily using propane/hexane standards for the FID/PID detectors and 17 chlorinated hydrocarbon standards for the HECD detector. Response factors based on three-point calibrations were calculated semimonthly. These were compared with daily response factors to monitor instrument drift. All checks were within ±15% of the accepted value for the RF. A summary of these activities is presented in Appendix R.

TABLE 29. SUMMARY OF ANALYTICAL VARIABILITY ON VARIAN 3700 GC[a]

Hydrocarbon Class	Gas		Sludge		Liquid	
	Mean Conc. (ug/m^3)	Precision (% CV)	Mean Conc. (ug/g)	Precision (% CV)	Mean Conc. (mg/L)	Precision (% CV)
Total Aromatics	140,500	3.5	144.9	114.7	31.5	6.5
Total Halogenated Hydrocarbons	75,750	44.5	70.1	78.9	30.1	11.2
Total Paraffins	51,800	20.5	98.2	18.3	12.1	74.8
Total NMHC	271,500	16.4	368.0	75.3	7.5	7.5
Total Olefins			32.8	50.7		

[a] Analytical precision based on results of duplicate analyses

TABLE 30. SUMMARY OF ANALYSES OF EPA QC SAMPLES

Compound	HECD Mean Recovery (%)	HECD Standard Deviation (ppbv-C)	HECD 95% Confidence Limits[a] (ppbv-C)	PID/FID Mean Recovery (%)	PID/FID Standard Deviation (ppbv-C)	PID/FID 95% Confidence Limits (ppbv-C)
Methylene Chloride	105	9.13	94-117			
1,1-Dichloroethane	69	3.54	65-73			
trans-1,2-dichloroethylene	88	2.12	85-91			
1,2-Dichloroethane	142	8.65	132-153			
Carbon tetrachloride	101	11.2	87-115			
Trichloroethene	98	7.73	89-108			
Dibromochloromethane	154	17.5	132-176			
1,1,2,2-tetrachloroethane	173	10.3	160-186			
Chlorobenzene	229	67.6	145-313			
Benzene				91	28.4	55-126
Toluene				88	2.28	85-91
Ethyl benzene				87	3.96	82-92

[a] Confidence limits for % recovery based for t-test for 5 analyses at

$$95\% \text{ confidence limits} = \bar{X} \pm \frac{ST_{n-1,\alpha}}{n}$$

where, $\bar{X}$ = mean
S = standard deviation
T = statistical table value
n = number of analyses
α = risk limit (i.e., 0.05)

TABLE 31. SUMMARY OF DRIFT CHECKS FOR VARIAN 3700 GC

Compound	HECD		PID/FID	
	Mean Error[a] (%)	Standard Deviation (ppbv-C)	Mean Error[a] (%)	Standard Deviation (ppbv-C)
1,1,1-Trichloroethane	-1.6	5.56		
Chloromethane	-6.4	11.8		
Vinyl chloride	-1.6	14.7		
Dichlorofluoromethane	-5.0	17.8		
Fluorotrichloromethane	-3.0	7.71		
1,1-dichloroethylene	0.71	10.3		
Methylene chloride	-0.42	7.67		
t-1,2-dichloroethene	-1.2	8.50		
1,1-dichloroethane	-0.86	5.65		
Chloroform	1.6	8.31		
1,2-dichloroethane	7.4	8.97		
Carbon tetrachloride	6.6	8.65		
1,2-dichloropropane	8.3	9.76		
Trichloroethylene	6.0	11.1		
1,1,2-trichloroethane	9.3	10.7		
Tetrachloroethylene	3.5	6.25		
Chlorobenzene	12.3	9.15		
Propane			-1.9	3.67
Hexane			-0.61	1.25

[a] Mean % error, m

$$m = \frac{RF_d - RF_m}{RF_m} \times 100$$

where, RF_d = daily single point response factor
RF_m = bimonthly triple point response factor

Table 32 presents a summary of blank analysis results on the Varian 3700. Data from individual blank analyses are presented in Appendix R. The mean concentration of total non-methane hydrocarbons reported in system blanks was 3.22 ppbv-C for HECD, and 50.6 ppbv-C for FID/PID.

Results of species identification checks of 12 standards for the Varian GC system are presented in Table 33. The laboratory procedure calls for manual identification of sample species if the automated system incorrectly identifies more than one of the 12 standards. Ethane and n-hexane were not correctly identified by the automated system because of coelution of ethane, ethene, and acetylene peaks, and the overlap of n-hexane and cis-3-hexene peaks. Species identifications in this program were subsequently made by manual inspection of the sample data. Concentrations were quantified within 50% of the true concentration for all 12 standards both days these QC checks were performed.

BYRON 401 THC ANALYZERS

Two Byron Model 401 THC analyzers were used on site to continuously monitor the inlet and outlet gas streams of the carbon absorption system. Quality control activities were identical for the two systems. These activities included:

- multipoint linearity checks,
- drift checks, and
- system blanks.

Results from the QC activities on the Byron 401 and Super 401 are summarized in Table 34. Acceptance criteria for the Byron 401 analyzers were:

- CV ≤20% for replicate determinations, and
- ±20% recovery of control samples.

Each morning three mixed standards were introduced to the analyzer to establish instrument linearity. The correlation coefficient, exceeded the minimum acceptance criteria of 0.995 in every case. Daily calibration results are presented in Appendix S.

A drift check was performed by analyzing the mid-level standard gas (used for the linearity check) at the end of each working day and comparing the results to the morning value. An estimate of precision based on these drift checks is presented in Table 35. The average difference between the morning and evening measured concentrations was -7.67% for the Byron 401 and -4.11% for the Super 401. Precision estimates based on the drift checks were 5.70% CV for the 401 and 4.06% CV for the Super 401. These are well within the acceptance criteria of 20% CV.

Estimates of accuracy based on daily analysis of a mixed standard of toluene, benzene, and chlorobenzene are summarized in Table 36. The average error was -4.6% for the Byron 401 and -11.8% for the Super 401 analyzers.

TABLE 32. SUMMARY OF DAILY BLANK SAMPLE ANALYSES FOR VARIAN 3700 GC

	HECD			FID/PID		
Blank Type	Average Value (ppbv-C)	Range (ppbv-C)	Number of Analyses	Average Value (ppbv-C)	Range (ppbv-C)	Number of Analyses
Gas	2.91	.022-9.32	8	14.1	5.61-53.0	11
Water	3.52	2.83-4.82	4	48.7	34.8-57.0	3
Water and Tetraglyme	3.22	0.15-7.95	7	88.9	61.1-103	7

TABLE 33. RESULTS OF OFF-SITE ANALYSIS OF 12 COMPONENT STANDARDS FOR SPECIFIES IDENTIFICATION CHECK

	10-8-84			10-9-84		
Compound	Measured Concentration (ppbv-C)	Difference from True Concentration (%)	ID	Measured Concentration (ppbv-C)	Difference from True Concentration (%)	ID
Ethane	31.1	5.1	-	31.5	6.4	-
Propane	122.4	-0.16	+	123.4	0.65	+
1-Butene	56.4	-13.1	+	56.7	-12.7	+
n-Butane	62.9	4.0	+	62.8	3.8	+
1-Hexene	83.3	-10.6	+	82.6	-11.4	+
n-Hexane	90.1	3.7	-	87.2	0.37	-
Ethyl benzene	98.9	-23.6	+	105.0	-18.9	+
n-Octane	112.7	-14.9	+	112.6	-15.0	+
Propyl benzene	94.4	3.5	+	96.7	6.1	+
n-Decane	120.6	-30.1	+	126.9	-26.5	+
Benzene	85.4	43.7	+	84.7	42.5	+
Toluene	100.2	-3.0	+	102.7	-5.8	+

+ = Correct Identification
- = Incorrect Identification

TABLE 34. SUMMARY OF QUALITY CONTROL CHECKS FOR BYRON THC ANALYSES

QC Check	Units	Byron 401		Byron Super 401	
		Average Value	Range	Average Value	Range
Multipoint linearity	Coefficient of variation	0.9998	0.9996-1.0000	0.9999	0.9999-0.9999
Drift check	% difference between measured and true value	-7.67	-2.46-(-14.9)	-4.11	-8.16-0
Mixed standard check	% difference between measured and true value	-4.64	-0.95-(-7.67)	-11.8	-4.65-(-17.6)
System blank	ppmv-C	2.1	1.0-3.1	0.9	0.5-1.7

TABLE 35. SUMMARY OF DRIFT CHECKS FOR BYRON THC ANALYZERS

Byron 401				Byron Super 401			
True Conc. (ppmv)	Measured Conc. (ppmv)	Average % Drift[a]	% CV[b]	True Conc. (ppmv)	Measured Conc. (ppmv)	Average % Drift[a]	% CV[b]
386.1	356.6	-7.67	5.70	386.1	370.2	-4.11	4.06

[a] Average % drift is given by:

$$\frac{\sum_{i}^{N}\left(\frac{\text{Measured Value}_i - \text{True Value}}{\text{True Value}}\right)100}{N}$$

[b] % CV represents the variation associated with the measured concentration of the standard taken over four days for each analyzer

TABLE 36. SUMMARY OF ACCURACY ESTIMATES FOR BYRON 401 ANALYZERS

	True Concentration[a] (ppmv)	Average Measured Concentration[a] (ppmv)	Average Error (%)	95% Confidence Limits (ppmv)
Byron 401	496.6	473.6	-4.63	453.0-494.1
Byron Super 401	496.6	438.2	-11.8	395.1-481.2

[a] Concentration of toluene standard.

The true value (496.6 ppmv) did not fall within the 95% confidence limits based on four tests for each analyzer. The recoveries of these standards were within the acceptance criteria of ±20%.

System blanks were obtained by introducing ultra high purity air through the sample acquisition system and measuring the total hydrocarbon concentration. The results are presented in Appendix S. The average concentration for nine blank analyses was 2.1 ppmv-C for the Byron 401 and 0.92 ppmv-C for the Byron Super 401. The standard deviation for these analyzers was 0.844 and 0.474 for the 401 and Super 401, respectively.

HNU GAS CHROMATOGRAPH

An HNU Model 301 GC was used on site to provide speciation data for the major compounds present in the inlet and outlet streams of the carbon absorption system. A multipoint linearity check was performed at the start of the test program. Single-point quantitative standards and blanks were run daily. All QC checks were within acceptance criteria.

REFERENCES

1. Determination of Stack Gas Velocity and Volumetric Flow Rate (Type 5 Pitot Tube), EPA Method 2, Environment Reporter, December 5, 1980, p. 23-33.

2. Sample and Velocity Traverses for Stationary Sources, EPA Method 1, Environment Report, December 5, 1980, p. 23-26.

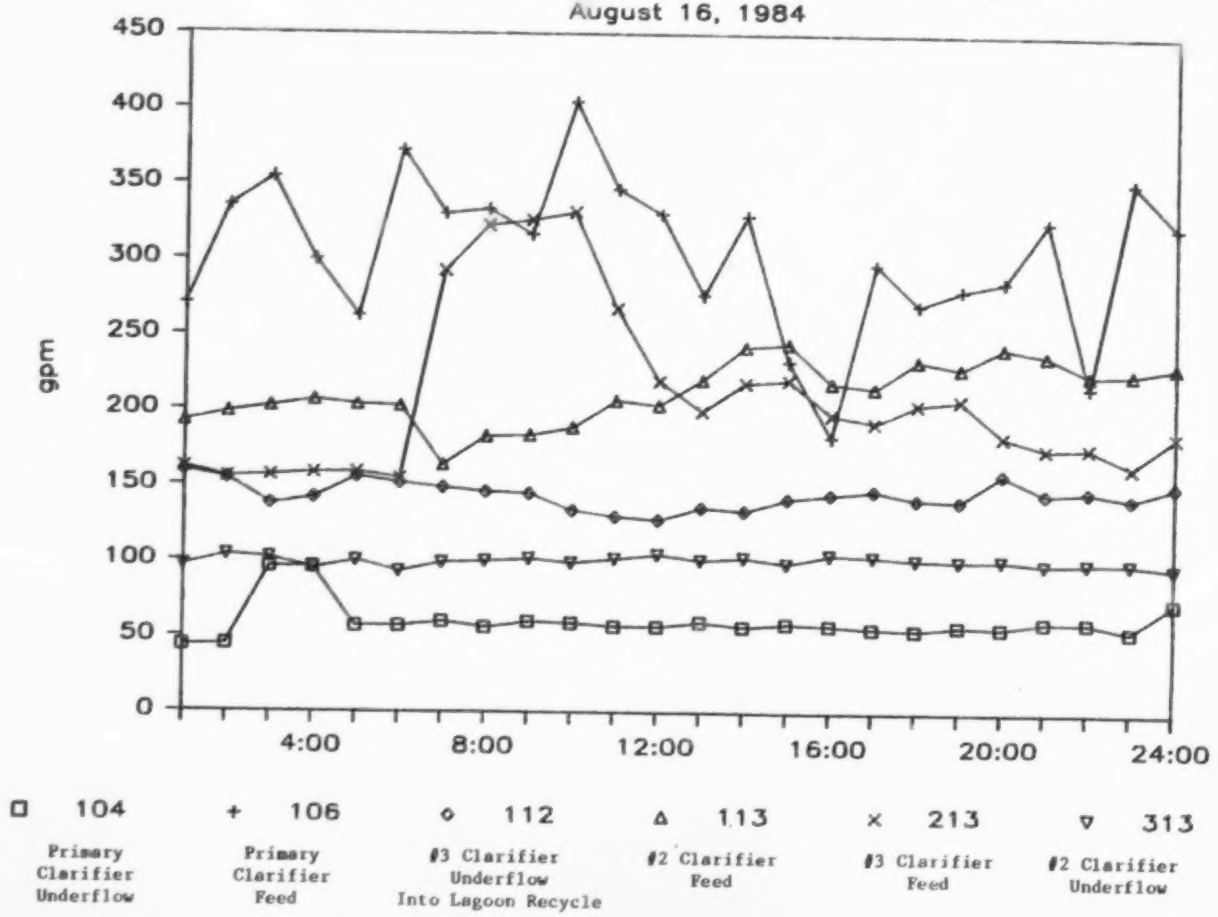
3. Farino, W., P. Spawn, M. Jasinski, and B. Murphy, Evaluation and Selection of Models for Estimating Air Emissions from Hazardous Waste Treatment and Disposal Facilities (Revised Draft Final Report) U.S. Environmental Protection Agency, Contract No. 68-02-3168, Assignment No. 77, (May 1983).

Appendix A

Hourly Averages of Process Flow Data - Upjohn Instrumentation

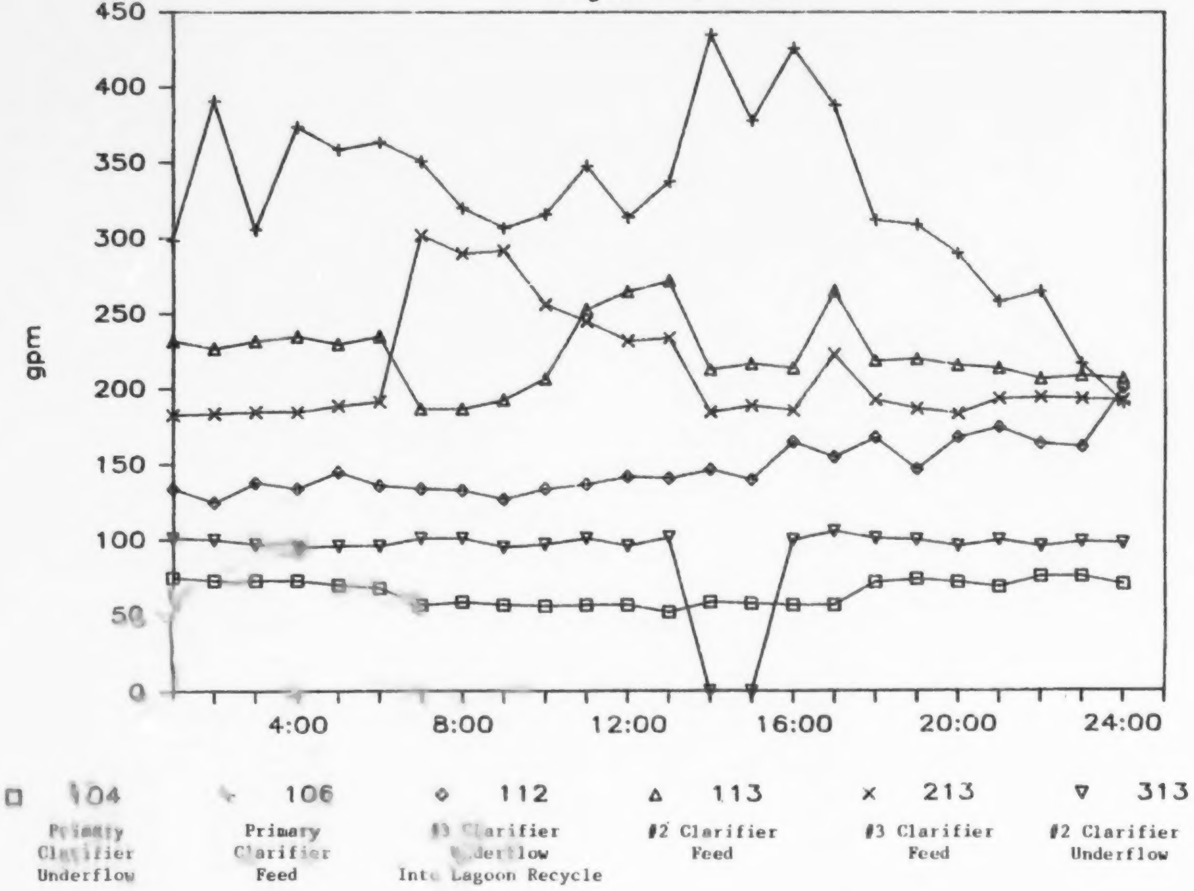
UPJOHN – NORTH HAVEN, CN

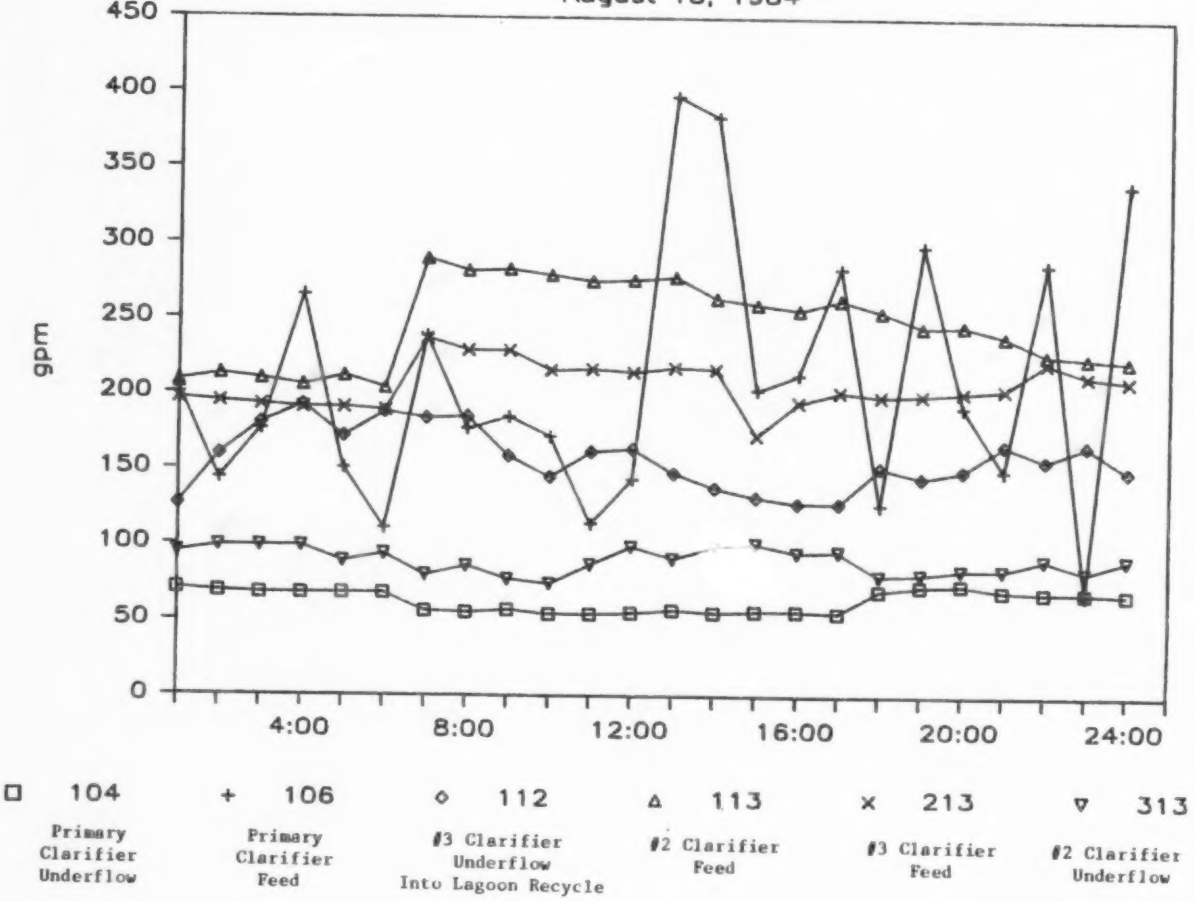
August 16, 1984



UPJOHN — NORTH HAVEN, CN

August 17, 1984



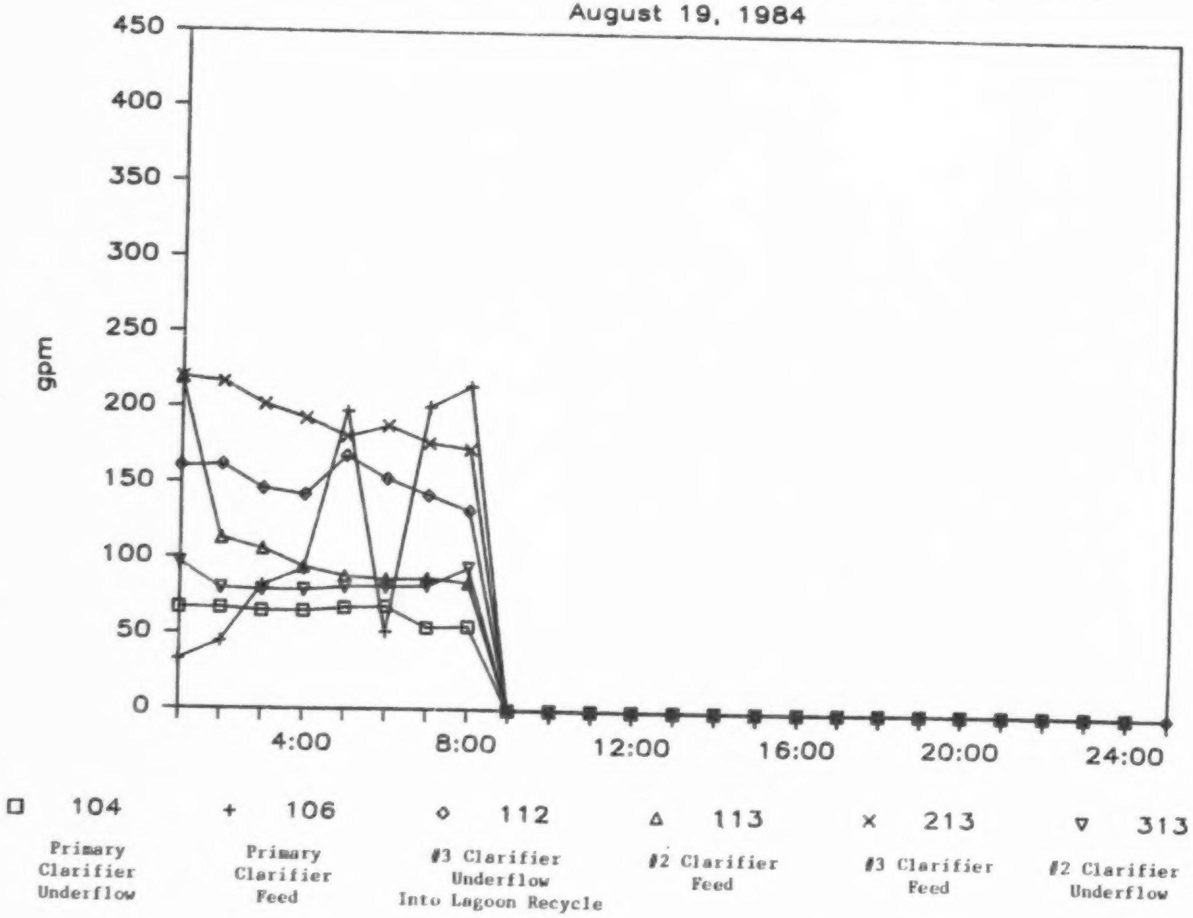


UPJOHN – NORTH HAVEN, CN

August 18, 1984

UPJOHN – NORTH HAVEN, CN

August 19, 1984



Appendix B

Example Calculations
For
Off-Site Analytical Calculations

1. Air Sample Concentrations

All sample components were quantitated on the basis of FID carbon response relative to propane or n-hexane. All C_2-C_4 compounds were quantitated against propane and all C_5-C_{11} compounds were quantitated against n-hexane. A quantitative standard of propane and n-hexane (referenced to NBS SRM propane) was analyzed each day. For each analysis, the operator entered the initial and final reservoir pressure, the sample dilution factor and the analysis type (standard or sample). The reservoir volume and standard concentrations were used by the Apple II to calculate sample volumes and response factors. The volume of gas was calculated using the following equation:

$$V_g = \frac{(P_2 - P_1)}{14.7} \ (3.55\ L) \qquad \text{(B-1)}$$

where: V_g = volume of sample or standard (L)
P_1 = initial reservoir pressure (psi)
P_2 = final reservoir pressure (psi)
3.55 L = reservoir volume (L)
14.7 = psi/atmosphere

Quantitative response factors were then calculated for each compound (propane or n-hexane) using the following equation:

$$RF = \frac{\text{area}}{C_s(V_g)} \qquad \text{(B-2)}$$

where: RF = response factor (area/nL-C)
area = peak area for propane or n-hexane
C_s= concentration of propane or n-hexane (ppbv-C (nL-C/L))
V_g= volume of standard used (L).

For quantitation of non-halogenated compounds, each peak was first identified, then the peak area was calculated according to the response factor for propane or n-hexane (propane for C_2-C_4 compounds, n-hexane for C_5-C_{11} compounds). All unidentified peaks were quantitated against n-hexane. The calculations to provide sample component quantitation was:

$$C_s = \frac{\text{area}}{RF(V_g)(D_f)} \qquad \text{(B-3)}$$

where:

C_s = concentration of sample component (ppbv-C)
area = area of sample component peak
RF = daily response factor for propane or n-hexane
V_g = volume of sample analyzed (L)
D_f = dilution factor.

The canister dilution factor was calculated as follows:

$$D_f = \frac{P_S - P_I}{P_T} \qquad \text{(B-4)}$$

where:

P_S = absolute canister pressure after sample collection,
P_I = initial absolute canister pressure, and
P_T = final absolute pressure after addition of UHP N_2.

Halogenated compounds were quantitated with a Hall electrolytic conductivity detector operated in the halogen mode. Individual response factors for halogenated compounds were generated by analyzing a 17 component certified gas standard. The response factors were calculated by the HP 3390A integrator using the following equation:

$$RF_i = \frac{\text{Amt.}_i}{\text{area}} \qquad \text{(B-5)}$$

where: Rf_i = response factor for compound i (nL-C/area)
$Amt._i$ = amount of compound i (nL-C)
Area = peak area for compound i.

The amount of compound i is determined as follows:

$$Amt._i = V_g \; C_i \qquad \text{(B-6)}$$

where: V_g = volume of gas standard (L)
C_i = concentration of compound i in standard (nL-C/L).

For sample components with retention times matching those of the compounds in the calibration standard, concentrations were calculated using the appropriate response factors. Unidentified components were quantitated using an average response factor obtained by computing the arithmetic mean for 16 of the response factors in the calibration standard. Chlorobenzene was excluded due to its atypical response factor. Halogenated sample components were calculated using the folowing equation:

$$C_i = \frac{(\text{area})\,(RF_i)}{(V_g)(D_f)} \qquad \text{(B-7)}$$

where: C_i = concentration of sample component i (ppbv-C)
area = peak area for compound i
RF_i = response factor for compound i (nL-C/area)
V_g = volume of sample analyzed (L)
D_f = dilution factor.

The volume of sample and dilution factor values were calculated using equations B-1 and B-4, respectively.

The final step in the calculation process was the conversion of concentration units from ppbv-C to ug/m^3 for each compound reported. This was accomplished by first converting the concentration value to ppbv by using:

$$C_v = \frac{C_c}{a} \tag{B-8}$$

where: C_v = concentration of sample component (ppbv)
C_c = concentration of sample component (nL-C/L)
a = number of carbon atoms per compound (nL-C/nL).

NOTE: 1 ppbv-C = 1 nL-C/L
1 ppbv = 1 nL/L

It was then necessary to convert the value obtained in equation B-8 to number of moles per liter by using:

$$N = C_v \left(\frac{1 \text{ n-mole}}{24.45 \text{ nL}} \right) \tag{B-9}$$

where: N= number of moles per liter (n-mole/L)
C_v = concentration of sample component (nL/L)
$\left(\frac{1 \text{ n-mole}}{24.45 \text{ nL}} \right)$ = derived from the ideal gas law.

This value is subsequently converted to mass per unit volume:

$$\text{ng/L} = (N)(NW) \tag{B-10}$$

or:

$$X_i = 1000\ (N)(MW)$$

where: N = number of moles per liter (n-mole/L)
MW = molecular weight of compound (ng/n-mole).
X_i = concentration of sample component i (ug/L)

The final step involves conversion of the value obtained from equation B-10 to micrograms per cubic meter:

$$Y_i = X_i\ (1L/0.001\ m^3) \qquad \text{(B-11)}$$

where: Y_i = concentration of sample component i (ug/m^3)
X_i = concentration of sample component i (ug/L)
($nL/0.001m^3$) = conversion factor.

The entire process for converting the concentration units can be reduced to a single equation:

$$Y_i = \left[40.9 \times 10^3\ (MW/a)\right] C_c \qquad \text{(B-12)}$$

where: Y_i = concentration of sample component i (ug/m^3)
MW = molecular weight of component i
a = number of carbon atoms in component i
C_c = concentration of sample component i (nL-C/L)

2. Liquid Sample Concentration

The quantitation of sample composite in liquid samples varies from that of air samples due to the difference in units used. The quantitative response factors for liquids (RF_L) include a conversion factor which changes the units of the air sample response factor from nL-C to ng-C. Both the n-hexane and the propane response factor is calculated by the same equation:

$$RF_L = \left(\frac{\text{area}}{C_{std}\ (V_g)}\right)\left(\frac{24.45\ \text{nL-C}}{12.011\ \text{ng-C}}\right) \qquad \text{(B-13)}$$

$$RF_L = RF\ (2.036)$$

where: C_{std} = concentration of propane or n-hexane (nL-C/L)
area = peak area for propane or n-hexane standard
V_g = volume of standard used (L)
RF_L = response factor for liquids (area/ng-C)
RF = response factor for air (area/nL-C).

The liquid sample component concentration is calculated using either the propane RF_L (C_2-C_4) or the n-hexane RF_L (C_5-C_{11}). The equation used was:

$$C_s = \frac{\text{area}}{RF_L\ (V_L)} \qquad \text{(B-14)}$$

where: C_s = concentration of sample component (ng-C/mL)
area = peak area for sample componet
RF_L = response factor for liquids (area/ng-C)
V_L = actual volume of sample purged (mL).

For purposes of comparison and reporting, the sample component concentration is converted to the units of mg/L by the following equation.

$$C = C_s \left(\frac{MW}{(12.011)a}\right)\left(\frac{1}{10^3}\right) \qquad \text{(B-15)}$$

where: C = concentration of sample component in mg/L
C_s = concentration of sample component in ng-C/mL
MW = molecular weight of sample component ng/nmole
12.011 = molecular weight of carbon, ng-C/nmole
a = number of carbon atoms in the sample molecule
$1/10^3$ = conversion from ng/mL to mg/L.

Quantitation of halogenated species in liquid samples was performed using a HECD and 26 component liquid purge standard. Using the external standard method of a HP-3390A integrator, response factors were calculated with the following equation.

$$RF_i = \frac{Amt._i}{area} \qquad \text{(B-16)}$$

where: Rf_i = response factor for species i (ng-L/area)
$Amt._i$ = amount (ng-C) of species i
area = peak area for standard species i.

The amount of species i was determined by the following equation:

$$Amt._i = V_{std}\, C_{std} \qquad \text{(B-17)}$$

where: V_{std} = volume of liquid purge standard (mL)
C_{std} = concentration of standard (ng-C/mL)

Species identified from the calibration table in the integrator were quantitated using the individual response factor. Unidentified peaks were quantitated using an average response factor obtained by computing the arithmetic mean for the 26 halogenated species. The calculation to provide sample component concentration was:

$$C_s = \frac{\text{area } (RF_i)}{V_L} \qquad \text{(B-18)}$$

where: C_s = concentration of sample componet (ng-L/mL)
RF_i = response factor for sample component or average
V_L = volume of sample purged (mL)

The unit conversion is the same for halogenated species as it is for non-halogenated species.

3. Slurry Sample Concentration

The calculations to determine the slurry sample component concentration are the same as they are for the liquid samples except for the determination of volume of sample analyzed. Instead of the V_L term shown in equations B-14 and B-18 the weight of sample in grams injected is substituted. All other injected calculation and unit conversions are the same as the air samples.

Appendix C
Example Process Calculations

RADIAN CORPORATION

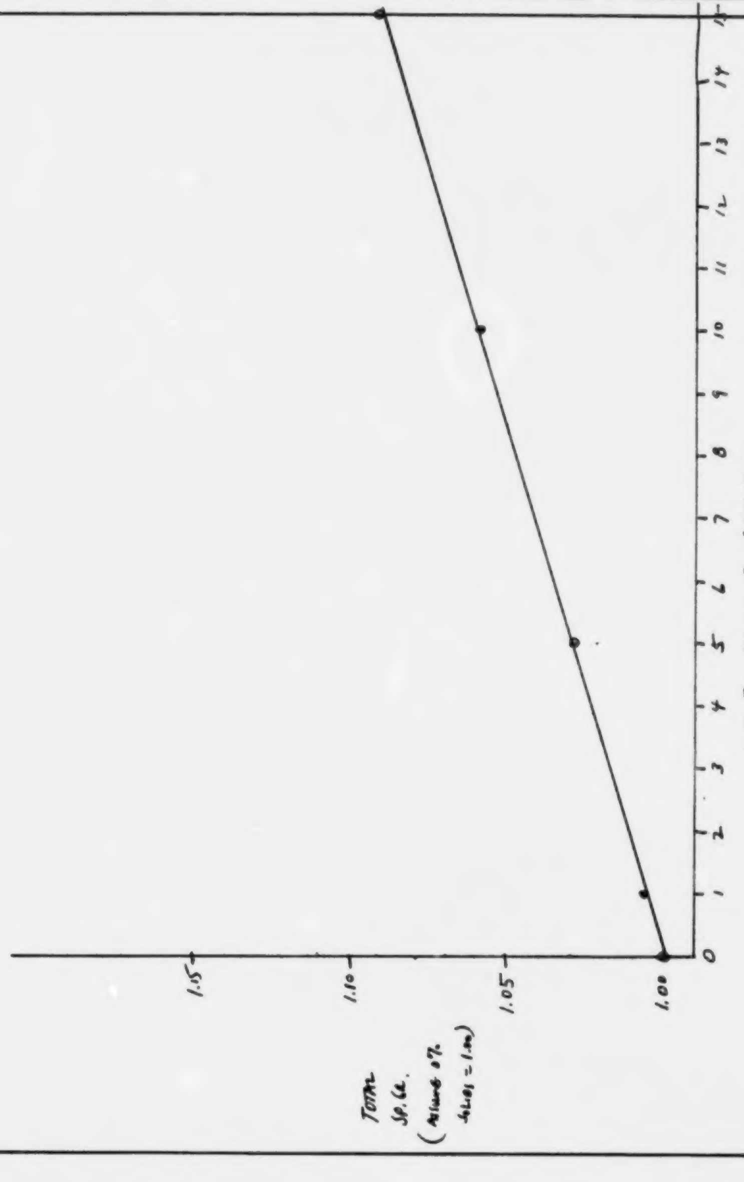
CALCULATION SHEET

CALC. NO. ______

SIGNATURE ______ DATE ______ CHECKED ______ DATE ______

PROJECT EPA - UPTON JOB NO. ______

SUBJECT CLARIFIER BALANCE SHEET 2 OF 2 SHEETS



4-81-3361

RADIAN
CORPORATION

CALCULATION SHEET

CALC. NO. ______

SIGNATURE (by ACT) DATE July 10 1985 CHECKED ______ DATE ______

PROJECT EPA - UPJOHN JOB NO. ______

SUBJECT INPUT DATA SHEET 1 OF 2 SHEETS

STREAM VALUES USED IN MATERIAL BALANCE CALCULATIONS

STREAM	Average Flow Rate L/m	Data Source	Solids content WT.%	Units	Organic Concentrations: Paraffins	Aromatics	Halogens	TOC
Primary Clarifier Feed	1080	Flowmeter	—					
Primary Clarifier Underflow	238	Flowmeter	12.6					
Recycle to Primary Clarifier	37.8	Plant est.	—					
Process water to Belt Filter	37.8	Plant est.	—					
Secondary Clarifier #2 Feed	863	Flowmeter	2.2	mg/L	12.8	9.66	5.15	36.5
Secondary Clarifier #2 Underflow	365	Flowmeter	3.8					
Excess Centrifuge Feed	57	Plant est.	—					
Secondary Clarifier #3 Feed	795	Flowmeter	—	mg/L	17.8	9.66	5.15	36.5
Secondary Clarifier #3 Underflow	568	Flowmeter	—					
Filter Belt Solids	—	—	16.4	mg/g	744	401	237	1210
South Centrifuge Solids	—	—	14.6	mg/g	121	44.2	21.3	248
North Centrifuge Solids	—	—	10.2	mg/g	221	36.9	10.5	54.0
Carbon adsorber Inlet	—	—	—	ppm ✓	75.5	52.8	261	392
Carbon adsorber Outlet	8.78 m/sec	Pitot	—	ppm ✓	71.6	53.6	308	450
Filtrate/Centrifugate	—	—	—	mg/L	16.3	12.6	5.00	34.5
Primary Clarifier Overflow	—	—	—	mg/L	15.8	37.9	79.9	18.5

4-81-3361

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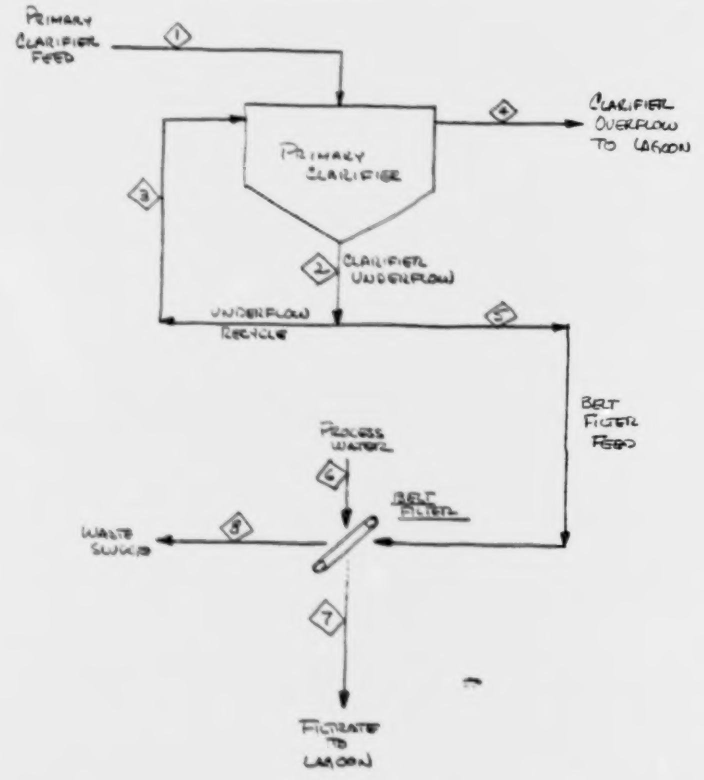
CALCULATION SHEET

CALC. NO. ____
SIGNATURE ____ DATE July 2, [illegible] CHECKED ____ DATE ____
PROJECT EPA - [illegible] JOB NO. ____
SUBJECT MAT BAL AROUND CLARIFIER/BELT FILTER SHEET 1 OF 6 SHEETS


PRIMARY CLARIFIER FEED
1
4
CLARIFIER OVERFLOW TO LAGOON
PRIMARY CLARIFIER
3
2
CLARIFIER UNDERFLOW
UNDERFLOW RECYCLE
5
BELT FILTER FEED
PROCESS WATER
6
BELT FILTER
WASTE SLUDGE
8
7
FILTRATE TO LAGOON

4 81 3361

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CALCULATION SHEET

CALC. NO. ______

SIGNATURE (by ACT) DATE July 2 1985 CHECKED ______ DATE ______

PROJECT EPA - UPJohn JOB NO. ______

SUBJECT ______ SHEET 2 OF ______ SHEETS

Material Balance Around Primary Clarifier and Belt Filter

STREAM ID	① Clarifier Feed	② Clarifier underflow	③ Clarifier Recycle	④ Clarifier overflow	⑤ Belt Filter Feed	⑥ Process water	⑦ Filtrate to lagoon	⑧ waste Sludge
Total Flow (v), L/min	1080ᵃ	238ᵃ	38ᶜ	875	200	38ᶜ	88	149
Solids content (w), wt%	2.5	12.6ᵃ	12.6ᵃ	0.0ᵈ	12.6ᵃ	0.0ᵈ	0.0ᵈ	16.4ᵃ
Liquid Flow Rate (L), Kg/min	1062	224	36	874	188	38	88	138
Solids Flow Rate (S) Kg/min	27	32	5	0	27	0	0	27
Total Flow Rate (M), Kg/min	1089	256	41	874	215	38	88	165
Specific Gravity of Streamᵇ (ρ)	1,014ᵇ	1,075ᵇ	1,075ᵇ	1.0ᵈ	1.075ᵇ	1.0ᵈ	1.0ᵈ	1,104ᵇ

a- measured value, b- estimated from experimental correlations, c- Plant estimated value, d- Assumed Value

4-81-3381

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CORPORATION

CALCULATION SHEET

CALC. NO. ____

SIGNATURE ____ DATE [illegible] CHECKED ____ DATE ____

PROJECT EPA-UPJ?-N JOB NO. ____

SUBJECT Mat Bal Around Clarifier/Belt Filter SHEET 3 OF 6 SHEETS

VOLUMETRIC BALANCE: CLARIFIER UNDERFLOW

$$V_5 = V_2 - V_3$$
$$V_5 = 338 - 78 = \underline{\underline{200}}\ \ell/\text{min}$$

VOLUMETRIC BALANCE: PRIMARY CLARIFIER

$$V_4 = V_1 - V_5$$
$$V_4 = 1075 - 200 = \underline{\underline{875}}\ \ell\text{PM}$$

MASS BALANCE: PRIMARY CLARIFIER

$$M_1 = M_4 + M_5$$
$$M_4 = 231\,(\text{gal/min}) \times 8.33\,(\text{lb/gal}) \times 1.0 \times 0.454\,(\text{kg/lb})$$
$$= \underline{874}\ \text{kg/mm}$$

$$M_5 = 53\,(\text{gal/min}) \times 8.33\,(\text{lb/gal}) \times 1.075 \times 0.454\,(\text{kg/lb})$$
$$= \underline{\underline{215}}\ \text{kg/min}$$

$$M_1 = 874 + 215 = \underline{\underline{1089}}\ \text{kg/mn}$$

$$M_2 = 63\,(\text{gal/mm}) \times 8.33\,(\text{lb/gal}) \times 1.075 \times 0.454\,(\text{kg/lb})$$
$$= \underline{\underline{256}}\ \text{kg/mm}$$

SOLIDS BALANCE: PRIMARY CLARIFIER

$$M_1 W_1 = M_4 \overset{0}{W_4} + M_5 W_5$$

$$W_1 = M_5 W_5 / M_1$$
$$= (215)(0.126)/1089$$
$$W_1 = \underline{\underline{0.0249}}$$

$$S_1 = M_1 W_1 = 1089 \times 0.025$$
$$= \underline{\underline{27}}\ \text{kg/min}$$

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CALCULATION SHEET

CALC. NO.
SIGNATURE DATE July [illegible] CHECKED DATE
PROJECT EPA- [illegible] JOB NO.
SUBJECT Mat Bal Around Clarifier/Belt Filter SHEET 4 OF 6 SHEETS

Clarifier Liquid Feed = $M_1 - S_1$
= 1089-27
= 1062 kg/mm

Clarifier Underflow Solids, S_2

$S_2 = M_2 W_2$
= 256 × 0.126 = 32 kg/mm

Underflow Liquid, $L_2 = M_2 - S_2$
= 256-32
= 224 kg/mm

Clarifier Recycle Flow, M_3 = 10 (gal/mm) × 8.33 (lb/gal) × 1.075 × 0.454 (kg/lb)

M_3 = 41 kg/min

Clarifier Recycle Solids, $S_3 = M_3 W_3$ = 41 × 0.126
= 5 kg/min

Clarifier Recycle Liquid, $L_3 = M_3 - S_3$
= 41-5
= 36 kg/min

Solids To Belt Filter, $S_5 = S_2 - S_3$
= 32-5
= 27 kg/mm

Liquid To Belt Filter = $M_5 - S_5$
= 215-27
= 188 kg/min

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CORPORATION

CALCULATION SHEET

CALC. NO. ____

SIGNATURE Thomas P. [illegible] DATE July 2 '85 CHECKED ____ DATE ____

PROJECT EPA - UPJOHN JOB NO. ____

SUBJECT Mat Bal Around Clarifier/Belt Filter SHEET 5 OF 6 SHEETS

MASS BALANCE AROUND BELT FILTER

$$M_8 + M_7 = M_6 + M_5$$

$$M_6 = 10(\text{gal/min}) \times 8.33\ \text{lb/gal} \times 1.0 \times 0.454\ (\text{kg/lb})$$
$$= \underline{\underline{38}}\ \text{kg/mm}$$

$$M_8 + M_7 = 38 + 215$$
$$M_8 + M_7 = 253 \qquad (A)$$

SOLIDS BALANCE AROUND BELT FILTER

$$S_5 + \cancelto{0}{S_6} = \cancelto{0}{S_7} + S_8$$

$$S_5 = 27$$
$$S_8 = M_8 W_8$$
$$= 0.164\ M_8$$
$$0.164\ M_8 = 27$$
$$M_8 = 27/0.164$$
$$M_8 = \underline{\underline{165}}\ \text{kg/mm}$$

FROM EQUATION (A)

$$M_7 = 253 - M_8$$
$$= 253 - 165$$
$$M_7 = \underline{\underline{88}}\ \text{kg/mm}$$

VOLUME FILTRATE, $V_7 = M_7/\rho_7$
$= 88\ \text{kg/min} / 1.0\ \text{kg/l}$
$= \underline{\underline{88}}\ \text{l/min}$

VOLUME WASTE SLUDGE, $V_8 = M_8/\rho_S$
$= 165\ \text{kg/min} / 1.11\ \text{kg/l}$
$= 149\ \text{l/min}$

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CORPORATION

CALCULATION SHEET

CALC. NO. ____

SIGNATURE ____ DATE July 2 [illegible] CHECKED ____ DATE ____

PROJECT EPA - UPJOHN JOB NO. ____

SUBJECT Mat. Bal. Around Clarifier/Belt Filter SHEET 6 OF 6 SHEETS

Waste Sludge Solids $= M_B W_B$
$= 165 \times 0.164$
$= 27$ kg/min

Waste Sludge Liquids $= M_B - S_B$
$= 165 - 27$
$= 138$ kg/min

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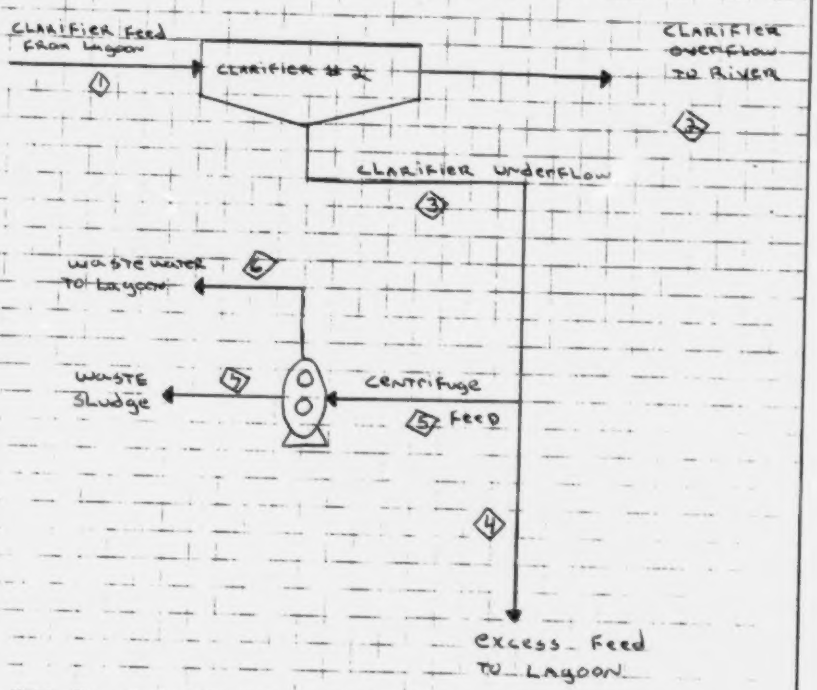
CORPORATION

CALCULATION SHEET

CALC. NO.
SIGNATURE DATE July 16 1985 CHECKED DATE
PROJECT EPA- UPJohn JOB NO.
SUBJECT CLARIFIER #2 Balance SHEET 1 OF 5 SHEETS

CLARIFIER #2 Material Balance


CLARIFIER Feed
FROM Lagoon
①
CLARIFIER #2
CLARIFIER
overflow
TO River
②
CLARIFIER underflow
③
waste water
TO Lagoon
⑥
waste
Sludge
⑦
centrifuge
⑤ Feed
④
excess Feed
TO LAGOON

4-81-3381

RADIAN
CORPORATION

CALCULATION SHEET

CALC. NO. ____

SIGNATURE Thomas P. Nelson (by [illegible]) DATE July 16, 1985 CHECKED ____ DATE ____

PROJECT EPA - UPJOHN JOB NO. ____

SUBJECT Clarifier #2 Balance SHEET 2 OF 5 SHEETS

Material Balance Around Secondary Clarifier and Centrifuge

STREAM I.D.	① Clarifier Feed	② Clarifier Overflow	③ Clarifier Underflow	④ Excess centrifuge feed	⑤ Centrifuge Feed	⑥ Washwater to [illegible]	⑦ Waste Sludge
Total Flow (V) L/min	863^a	498	365^a	57^b	308	218	90
Solids Content (w), wt %	2.2^a	1.0	3.8^a	3.8	3.8	0^c	12.4
Liquid Flowrate (L) kg/min	853	494	359	56.1	303	218	84.8
Solids Flowrate (S) kg/min	19.2	5.0	14.2	2.22	12.0	0	12.0
Total Flowrate (m) kg/min	872	499	373	58.3	315	218	96.8
Specific Gravity of Stream (ρ)	1.011^d	1.00^d	1.022^d	1.022^d	1.022^d	1.0	1.025^d

[a] measured value

[b] Plant estimate

[c] Assumed value

[d] Estimated from experimental correlation

4-81-3361

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CALCULATION SHEET

CALC. NO. ____

SIGNATURE Karen P. Nelson (by wt) DATE July 16, 1985 CHECKED ____ DATE ____
PROJECT EPA - UpJohn JOB NO. ____
SUBJECT Clarifier #2 Balance SHEET 3 OF 5 SHEETS

Volumetric Balance; Clarifier overflow

$V_2 = V_1 = V_3$
$V_2 = 863 - 365 = \underline{\underline{498}}$ L/min

Volumetric Balance; centrifuge Feed

$V_5 = V_3 - V_4$
$V_5 = 365 - 57 = \underline{\underline{308}}$ L/min

Mass Balance; secondary clarifier #2 / centrifuge

$M_1 = 863$ L/min x 1.011 Kg/L
= 372 Kg/min
$M_3 = 365$ L/min x 1.022 Kg/L
= 373 Kg/min
$M_2 = M_1 - M_3$
= 372 - 373 = 499 Kg/min
$M_4 = 57$ L/min x 1.022 Kg/L
= 58.3
$M_5 = M_3 - M_4$
= 373 - 58.3 = 315 Kg/min

Solids mass Balance; secondary clarifier

$S_1 = 872$ Kg/min x 0.022 Kg solids / Kg
= 19.2 Kg/min
$S_3 = 373$ Kg/min x 0.038 Kg solids / Kg
= 14.2 Kg/min
$S_2 = S_1 - S_3$
= 19.2 - 14.2 = 5.0 Kg/min

4-81-3381

RADIAN
CORPORATION

CALCULATION SHEET

CALC. NO. ______

SIGNATURE (by WE) DATE July 16 1985 CHECKED ______ DATE ______

PROJECT EPA - UPJOHN JOB NO. ______

SUBJECT Clarifier #2 Balance SHEET 4 OF 5 SHEETS

Solids mass Balance : centrifuge

$S_4 = M_4 \times \rho_4$
$= 58.3 \text{ kg/min} \times 0.038 \text{ kg solids/kg}$
$= 2.22 \text{ kg/min}$
$S_5 = S_3 - S_4$
$= 14.2 - 2.22 = 12.0 \text{ kg/min}$
$S_6 = 0$ (assumed no solids in centrifuge)
$S_7 = S_5 - S_6$
$= 12.0 - 0 = 12.0 \text{ kg/min}$

Total mass flow of waste sludge / waste water

$M_7 = 12.0 \text{ kg}_s\text{/min} / (0.124 \text{ kg}_s / \text{total kg})$
$= 96.8 \text{ kg/min}$
$M_6 = M_5 - M_7$
$= 315 - 96.8 = 218 \text{ kg/min}$

Volumetric Balance : waste water / waste sludge

$M_6 = 218 \text{ kg/min} / 1.0 \text{ kg/L}$
$= 218 \text{ L/min}$
$M_7 = M_5 - M_6$
$= 308 - 218 = 90 \text{ L/min}$

Liquids mass Balance

$L_1 = M_1 - S_1$
$= 872 - 19.2 = 853 \text{ kg/min}$
$L_2 = M_2 - S_2$
$= 499 - 5.0 = 494 \text{ kg/min}$
$L_3 = M_3 - S_3$
$= 373 - 14.2 = 359 \text{ kg/min}$

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CALCULATION SHEET

SIGNATURE (for) DATE July 16, 1985 CHECKED ____ CALC. NO. ____ DATE ____
PROJECT EPA - UPJOHN JOB NO. ____
SUBJECT Clarifier #2 Balance SHEET 5 OF 5 SHEETS

Liquid mass Balance (con't)

$$L_4 = M_4 - S_4$$
$$= 58.3 - 2.22 = 56.1 \text{ kg/min}$$
$$L_5 = M_5 - S_5$$
$$= 315 - 12.0 = 303 \text{ kg/min}$$
$$L_6 = M_6 - S_6$$
$$= 218 - 0 = 218 \text{ kg/min}$$
$$L_7 = M_7 - S_7$$
$$= 96.8 - 12.0 = 84.8 \text{ kg/min}$$

4-81-3361

RADIAN CORPORATION

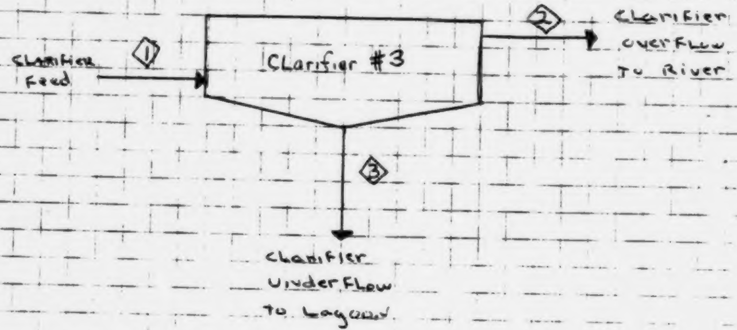
CALCULATION SHEET

CALC. NO.

SIGNATURE DATE July 16 1985 CHECKED DATE

PROJECT EPA - UPJohn JOB NO.

SUBJECT Mass Balance Around clarifier #3 SHEET 1 OF 4 SHEETS


Clarifier Feed
①
Clarifier #3
②
Clarifier overFlow To River
③
Clarifier underFlow To Lagoon

4-81-3381

RADIAN
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CALCULATION SHEET

CALC. NO.

SIGNATURE DATE July 18, 1985 CHECKED DATE

PROJECT EPA- UPJohn JOB NO.

SUBJECT Clarifier #3 Balance SHEET 2 OF 4 SHEETS

Material Balance Around Clarifier #3

STREAM ID	① Clarifier Feed	② Clarifier Overflow to River	③ Clarifier Underflow to Lagoon
Total Flow (V) L/min	795	227	563
Solids Content (W), wt %	2.2[a]	0[c]	3.05
Liquid Flowrate (L), Kg/min	786	224	
Solids Flowrate (S), Kg/min	17.7	0	17.7
Total Flowrate (M), Kg/min	804	224	580
Specific Gravity of stream (ρ)	1.011[d]	1.00[d]	1.022[d]

[a] measured value, [c] Assumed Value

[b] Plant estimate, [d] Estimated from an experimental correlation

4-81-3301

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO.

SIGNATURE DATE July 18 1985 CHECKED DATE

PROJECT EPA - UPJOHN JOB NO.

SUBJECT Clarifier #3 Balance SHEET 3 OF 4 SHEETS

Volumetric Balance: Clarifier overflow

$V_2 = V_1 - V_3$

$= 795 - 568 = 227$ L/min

Mass Balance

$M_1 = V_1 \times 1.011$ Kg/L

$= 795 \times 1.011 = 804$ Kg/min

$M_3 = V_3 \times 1.022$ Kg/L

$= 568 \times 1.022 = 580$ Kg/min

$M_2 = M_1 - M_3$

$= 804 - 580 = 224$

Solids Mass Balance

$S_1 = M_1 \times W_1 / 100$

$= 804$ Kg/min $\times$ 2.2 Kg/Kg $/100 = 17.7$ Kg/min

$S_2 = M_2 \times W_2 / 100$

$= 224$ Kg/min $\times 0 / 100 = 0$ Kg/min

$S_3 = S_1 - S_2$

$= 17.7$ Kg/min $- 0 = 17.7$ Kg/min

$W_3 = S_3 / M_3 \times 100$

$= 17.7$ Kg/min $/ 580$ Kg/min $\times 100$

$= 3.05$ %

Liquids Mass Balance

$L_1 = M_1 - S_1$

$= 804 - 17.7 = 786$ Kg/min

$L_2 = M_2 - S_2$

$= 224$ Kg/min $- 0 = 224$ Kg/min

4-81-3361

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CALCULATION SHEET

CALC. NO. ______

SIGNATURE ______ DATE July 18 1985 CHECKED ______ DATE ______

PROJECT EPA - UPJOHN JOB NO. ______

SUBJECT Clarifier #3 Balance SHEET 4 OF 4 SHEETS

Liquid Mass Balance (con't)

$L_3 = m_3 - S_3$

$= 584 \text{ kg/min} - 17.7 \text{ kg/min}$

$= 562. \text{ kg/min}$

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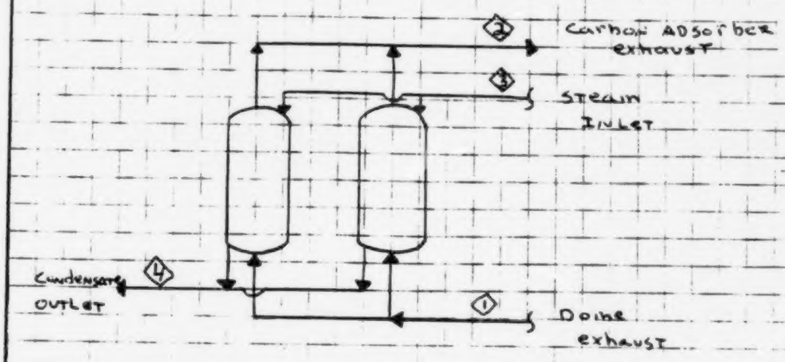
RADIAN CORPORATION

CALCULATION SHEET

CALC. NO. ____
SIGNATURE ____ DATE July 21 1985 CHECKED ____ DATE ____
PROJECT EPA - UPJOHN JOB NO. ____
SUBJECT Matl Balance Around Carbon Adsorber SHEET 1 OF 4 SHEETS



2
Carbon Adsorber exhaust
3
Steam Inlet
Condensate Outlet
4
1
Dome exhaust

Carbon Adsorber Operation
- One Bed Adsorbing at all times
- One Bed Regenerating 24-HR cycle
  - ① 12 HRS steaming
  - ② 12 HRS cooldown

4-81-3381

RADIAN CORPORATION CALCULATION SHEET

CALC. NO. ____

SIGNATURE ____ DATE July 21 1985 CHECKED ____ DATE ____

PROJECT EPA- UPJOHN JOB NO. ____

SUBJECT Carbon ADsorber Balance SHEET 2 OF 4 SHEETS

Material Balance Around Carbon ADsorber

	① Carbon ADsorBER INLET	② Carbon ADsorber OUTLET	③ Steam INLET	④ Condensate OUTLET
Gas Flow rate (V), m^3/sec	1.34	1.34^a	NA	NA
Liquid Flowrate (L), Kg/min	2.90	2.90	15^b	15
Total Flowrate (m), Kg/min	96.5	96.5	15	15
TNMHC conc (Ave) (C)	392^a	450^a	NA	NA
TNMHC Flowrate (H), Kg/min	0.123	0.141	0	NA

^{a} Measured Value

^{b} Plant Estimate

^{c} Calculated Based on Total Liquid Flow

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CALCULATION SHEET

CALC. NO. ____
SIGNATURE (by WET) DATE July 21 1985 CHECKED ____ DATE ____
PROJECT EPA - UPJOHN JOB NO. ____
SUBJECT Carbon Adsorber Balance SHEET 3 OF 4 SHEETS

Carbon Adsorber outlet volumetric Flowrate

V_2 = Ave Gas Flowrate x Duct Area x 520 °R / Gas Temp °R
= 8.78 m/sec x [(0.457)^2 x π/4] x 520 °R / 557 °R

= 1.34 m^3/sec
@ 60 °F STD conditions

Carbon Adsorber outlet Mass Flowrate

m_2 = V_2 x 1.20 Kg/m^3 x 60 sec/min
= 1.34 x 1.20 x 60 = 96.5 Kg/min

Carbon Adsorber outlet water Flowrate

outlet Humidity (Sat'd @ 309 °K)
= 0.131 Kg H_2O / Kg dry air

$L_2 = M_2$ x 0.031/(1 + 0.031)
= 96.5 x 0.031/(1 + 0.031) = 2.90

$L_1 = L_2$ = 2.90

OUTLET TNMHC Flowrate

$H_2 = M_2 / MW_{air}$ x C_2 x MW_{HC}
= 96.5 Kg/min / 28.4 x 450/10^6 x 92 Kg/Kg-mole
= 0.141 Kg/min

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CALCULATION SHEET

CALC. NO. ____

SIGNATURE Thomas P. Nelson (by WCT) DATE July 21 1985 CHECKED ____ DATE ____

PROJECT EPA - UPJohn JOB NO. ____

SUBJECT Carbon ADsorber Balance SHEET 4 OF 4 SHEETS

INLET TNMHC FLowrate

$H_1 = M_1 / MW_{air} \times C_1 \times MW_{HC}$
$= 96.5$ Kg/min $/ 28.4 \times 392/10^6 \times 92$ Kg/Kg-mole
$= 0.123$

condensate outLet TNMHC

$H_4 = H_1 - H_2$
$= 0.123 - 0.141 = -0.018$ Kg/min

4-81-3381

RADIAN CORPORATION

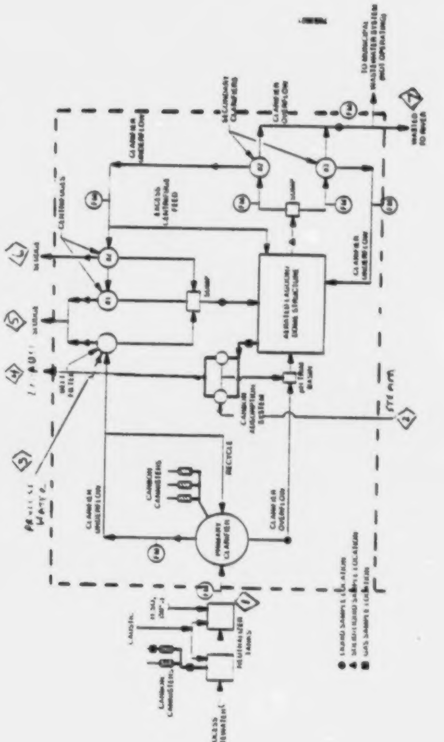
CALCULATION SHEET

CALC. NO. ________

SIGNATURE ________ DATE July 29 '85 CHECKED ________ DATE ________

PROJECT EPA-UPJOHN JOB NO. ________

SUBJECT MATL BALANCE AROUND WASTEWATER TREATMENT FACILITY SHEET 1 OF 7 SHEETS


PROCESS WASTEWATERS
CARBON CANNISTERS
CAUSTIC
H_2SO_4 DIP-4
NEUTRALIZER TANKS
1
PRIMARY CLARIFIER
CLARIFIER UNDERFLOW
CARBON CANNISTERS
RECYCLE
CLARIFIER OVERFLOW
PROCESS WATER
3
4
LIQUID
BELT FILTER
5
SLUDGE
6
SLUDGE
CENTRIFUGES
#1
#2
SUMP
CARBON ADSORPTION SYSTEM
pH TRIM BASIN
AERATED LAGOON/ DOME STRUCTURE
EXCESS CENTRIFUGE FEED
CLARIFIER UNDERFLOW
SECONDARY CLARIFIERS
#2
#3
SUMP
CLARIFIER OVERFLOW
CLARIFIER UNDERFLOW
FM
TO MUNICIPAL WASTEWATER SYSTEM (NOT OPERATING)
WASTED TO RIVER
7
STEAM
2
● LIQUID SAMPLE LOCATION
▲ SOLID/LIQUID SAMPLE LOCATION
■ GAS SAMPLE LOCATION

4 81 3361

RADIAN CORPORATION CALCULATION SHEET

SIGNATURE ________ DATE July 24 1985 CHECKED ________ DATE ________ CALC. NO. ________
PROJECT EPA - UPJohn JOB NO. ________
SUBJECT WNT Matl Balance SHEET 2 OF 7 SHEETS

OVERALL TNMHC Material Balance Data

STREAM ID	① Primary Clarifier Feed	of Primary Clarifier Overflow	③ Process Water	④ Carbon Adsorber Exhaust	⑤ Filter Belt Sludge	⑥ Centrifuge Sludge	⑦ Waste-water
Total Flow (m) kg/min	1089[a]	874[b]	33[c]	96.5[a]	16 5[b]	96.8[b]	718[b]
TNMHC Conc. (H)	389 mg/L	156 mg/L[a]	0	460 ppmv[a]	146 µg/g[a]	142 µg/g[c]	36.5 mg/L[a]
TNMHC Flow (TH), kg/min	.0418	0.150	0	0.141[b]	0.241	0.014	0.027
Specific Gravity of stream (ρ)	1.014[d]	1.0	1.0	—	1.104[d]	1.075[d]	1.0

[a] measured value

[b] calculated value

[c] Plant estimate

[d] Estimated from Experimental correlation

4-81-3361

RADIAN
CORPORATION

CALCULATION SHEET

CALC. NO. ____________

SIGNATURE ____________ DATE July 29 1986 CHECKED ____________ DATE ____________

PROJECT EPA - UP John JOB NO. ____________

SUBJECT OVERALL Balances - WWT SHEET 3 OF 7 SHEETS

OVERALL WATER Balance

INLET

	Kg/min	Data source
① Primary clarifier Feed	1062	PC
② carbon adsorber steam	15	CA
③ Process water	38	PC
TOTAL	1115	

OUTLET

④ carbon adsorber exhaust	3	CA
⑤ Filter belt sludge	138	PC
⑥ centrifuge sludge	85	#2C
⑦ waste water	718	#2C + #3C
TOTAL	944	

% closure = outlet/inlet x 100
= 944/1115 x 100
= 84.7%

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CORPORATION

CALCULATION SHEET

CALC. NO. ______
SIGNATURE Thomas P Nelson DATE July 29 198 CHECKED ______ DATE ______
PROJECT EPA - UPJohn JOB NO. ______
SUBJECT WWT Balance SHEET 4 OF 7 SHEETS

OVERALL SOLIDS Balance

INLET

	kg/min	Data Source
① Primary Clarifier Feed	27	PC
TOTAL	27	

OUTLET

⑤ Filter Belt sludge	27	PC
⑥ centrifuge sludge	12	#2C
⑦ wastewater (overflow sludge)	5	#2C
total	44	

% closure = outlet / inlet x 100
= 44 / 27 x 100
= 163%

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CALCULATION SHEET

CALC. NO. ________
SIGNATURE Thomas P. Nelson (by WCT) DATE July 29 1985 CHECKED ________ DATE ________
PROJECT EPA - UPJohn JOB NO. ________
SUBJECT WWT Balance SHEET 5 OF 7 SHEETS

TNMHC Mass Balance: Primary clarifier overflow + Filtrate

$TF_{of} = M_{of} \times H_{os} / \rho_{of}$
$= (875 \text{ kg/min} \quad 88 \text{ kg/min}) \times 184 \text{ mg/L}$
$\times 10^{-6} \text{ kg/mg} / 1.0$
$= 0.177$

TNMHC Mass Balance: Filter Delta sludge

$TF_5 = M_5 \times H_5$
$= 165 \text{ kg/min} \times 1460 \text{ mg/g} \times 10^{-6} \text{ g/mg}$
$= 0.241 \text{ kg/min}$

TNMHC Mass Balance: centrifuge sludge

$TF_6 = M_6 \times H_6$
$= 96.8 \text{ kg/min} \times 166 \text{ mg/g} \times 10^{-6} \text{ g/mg}$
$= 0.016 \text{ kg/min}$

TNMHC Mass Balance: waste water

$TF_7 = M_7 \times H_7 / \rho_7$
$= 718 \text{ kg/min} \times 36.5 \text{ mg/L} / 1.0 \text{ kg/L} \times 10^{-6} \text{ kg/mg}$
$= 0.026$

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CALCULATION SHEET

CALC. NO.

SIGNATURE DATE July 29 1985 CHECKED DATE

PROJECT EPA - UPJOHN JOB NO.

SUBJECT WWT Balance SHEET 6 OF 7 SHEETS

TNMHC Mass Balance; Primary clarifier Feed

$TF_1 = TF_{at} + TF_s$

$= 0.177$ kg/min $+ 0.241$ kg/min

$= 0.418$ kg/min

$H_1 = TF_1 / (m_1 / \rho_1) \times 10^6$

$= 0.418 / (1089 / 1.014) \times 10^6$

$= 389$ mg/L

OVERALL TNMHC Balance

	kg/min
INLET	
① Primary clarifier Feed	0.418
TOTAL	0.418
OUTLET	
④ carbon ADsorber exhaust	0.141
⑤ Filter Belt sludge	0.241
⑥ centrifuge sludge	0.016
⑦ wastewater	0.026
TOTAL	0.424

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CALCULATION SHEET

CALC. NO.
SIGNATURE DATE July 29 1985 CHECKED DATE
PROJECT EPA - UPJohn JOB NO.
SUBJECT WWT Balance SHEET 7 OF 7 SHEETS

OVERALL TNMHC Balance (con't)

$\%$ Closure = outlet / inlet × 100
= 0.424 / 0.418 × 100
= 101.4 %

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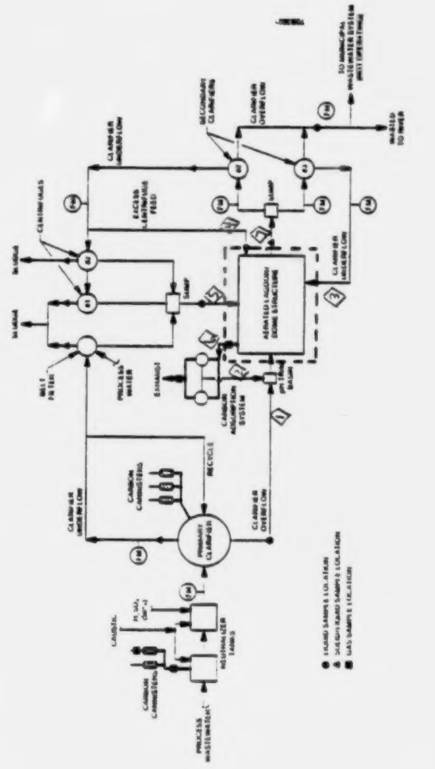
CALCULATION SHEET

CALC. NO. ______

SIGNATURE Warren P. [illegible] DATE July 24, '85 CHECKED ______ DATE ______

PROJECT EPA-UPJOHN JOB NO. ______

SUBJECT MAT'L BALANCE AROUND LAGOON SHEET 1 OF 4 SHEETS


PROCESS WASTEWATER
CARBON CANNISTERS
CAUSTIC
H_2SO_4
NEUTRALIZER TANKS
PRIMARY CLARIFIER
CLARIFIER UNDERFLOW
CLARIFIER OVERFLOW
CARBON CANNISTERS
RECYCLE
BELT FILTER
PROCESS WATER
EXHAUST
CARBON ADSORPTION SYSTEM
pH TRIM BASIN
1
2
3
4
5
6
7
AERATED LAGOON DOME STRUCTURE
SUMP
CENTRIFUGES
EXCESS CENTRIFUGE FEED
CLARIFIER UNDERFLOW
SECONDARY CLARIFIERS
CLARIFIER OVERFLOW
WASTED TO RIVER
TO MUNICIPAL WASTEWATER SYSTEM
● LIQUID SAMPLE LOCATION
▲ SLUDGE/LIQUID SAMPLE LOCATION
■ GAS SAMPLE LOCATION

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CALCULATION SHEET

CALC. NO.
SIGNATURE DATE July 29 1985 CHECKED DATE
PROJECT EPA- UPJOHN JOB NO.
SUBJECT LAGOON BaLance SHEET 2 OF 4 SHEETS

LAGOON TNMHC Material Balance Data

STREAM ID	① Primary clarifier overflow	② KA condensate	③ clarifier #3 Underflow	④ excess centrifuge Feed	⑤ Filtrate/ centrifuge	⑥ KA exhaust	⑦ #2+3 clarifier Feed
Total Flow (m), Kg/min	874^b	15^c	580^a	68,3^c	302^b	96.5^b	1676^b
TNMHC conc (H)	184 mg/L^a	–	36,5 mg/L^e	36.5 mg/L^e	36.5 mg/L^a	392 ppm^d	36.5 mg/L
TNMHC Flow (TH), Kg/min	0.193^b	0^b	0.021	0.002	0.011	0.123^b	0.060
Specific gravity of stream (ρ)	1.0	–	1.022	1.022	1.0	–	1.011

^{a}Measured value
^{b}Calculated value
^{c}Plant Estimate
^{d}Estimated From Experimental Correlation
^{e}Assumed value

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CALCULATION SHEET

CALC. NO. ______
SIGNATURE ______ DATE July 29, 1985 CHECKED ______ DATE ______
PROJECT EPA - UPJOHN JOB NO. ______
SUBJECT Lagoon Balance SHEET 3 OF 4 SHEETS

TNMHC Material Balance: Filtrate / centrifugate

$TF_5 = M_5 \times H_5 / \rho_5$
$= 306 \text{ kg/min} \times 36.5 \text{ mg/L} / 1.0 \text{ kg/L} \times 10^{-6} \text{ kg/mg}$
$= 0.011$

TNMHC Material Balance: #2, #3 clarifier Feed

$TF_7 = M_7 \times H_7 / \rho_7$
$= 1676 \text{ kg/min} \times 36.5 \text{ mg/L} / 1.011 \text{ kg/L} \times 10^{-6} \text{ kg/mg}$
$= 0.060 \text{ kg/min}$

TNMHC Material Balance: clarifier #3 Underflow + excess centrifuge Feed

$TF_3 = M_3 \times H_3 / \rho_3$
$= 580 \text{ kg/min} \times 36.5 \text{ mg/L} / 1.022 \text{ kg/L} \times 10^{-6} \text{ kg/mg}$
$= 0.021 \text{ kg/min}$

$TF_4 = M_4 \times H_4 / \rho_4$
$= 58.3 \text{ kg/min} \times 36.5 \text{ mg/L} / 1.022 \text{ kg/L} \times 10^{-6} \text{ kg/mg}$
$= 0.002 \text{ kg/min}$

OVERALL TNMHC Balance

INLET

	Kg/min
① Primary clarifier overflow	0.177
② CA Condensate	0
③ clarifier #3 Underflow	0.021
④ excess centrifuge Feed	0.002
⑤ Filtrate / centrifugate	0.011
TOTAL	0.211

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CALCULATION SHEET

CALC. NO.

SIGNATURE DATE July 29, 1985 CHECKED DATE

PROJECT EPA - UPJohn JOB NO.

SUBJECT Lagoon Balance SHEET 4 OF 4 SHEETS

OVERALL TNMHC Balance (con't)

OUTLet

	kg/min
⑥ carbon adsorber exhaust	0.123
⑦ #2, #3 clarifier feed	0.060
TOTAL	0.183

% closure = OUTLET / INLET x 100
= 0.183 / 0.211 x 100
= 86.7 %

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CALCULATION SHEET

CALC. NO. ______

SIGNATURE Thomas P Nelson DATE 11/7/84 CHECKED ______ DATE ______

PROJECT EPA - UPJOHN JOB NO. ______

SUBJECT 55- Gallon Carbon Drum Loading SHEET 1 OF 1 SHEETS

55- Gallon Carbon Drum Loading

WT OF CARBON IN TEST CANISTER
start - 449.5 g
finish - 477.3 g

WT OF NMHC ON TEST CARBON AFTER TEST
- 246 μg/g

Length of Test
- 22.5 hours

EMISSION RATE

$$= \frac{477.3 \text{ g} \times 246\ \mu\text{g/g} \times 10^{-9}\ \text{kg}/\mu\text{g}}{22.5 \text{ hours} \times 60 \text{ min/hr}}$$

$$= 8.7 \times 10^{-8} \text{ kg/min}$$

$$(= 1.15 \times 10^{-5} \text{ lb/hr})$$

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APPENDIX D

MONTE CARLO TECHNIQUE AND EXAMPLE VARIABILITY CALCULATIONS

Confidence Limit Estimation (Precision Estimates)

Estimates of the precision or uncertainty of the individual emission rate values were developed using Monte Carlo simulations. With this technique each input parameter is perturbed randomly to simulate the actual variation that would occur in practice. In this simulation, each input parameter was assumed to have a Gaussian distribution, with a standard deviation (or coefficient of variation) that was estimated from existing data, prior experience, literature values, or actual field measurements. The output response emission rate was computed from the simulated input of these measurement parameter values. This process is repeated for 400 simulated trials, and the 2.5 and 97.5 percentiles of the calculated values were selected as estimates of the lower and upper 95% confidence limits on the computed or predicted percentage closure or emission rate. These precision estimates are based only on the measurement techniques for the input data and do not take into account environmental variations. As such, the individual measured or predicted value represents the best estimate for one point in time for purposes of comparison.

For several cases in which more than one air emission measurement was taken at a given location, overall emission and precision estimates were also computed. Confidence intervals for the mean emission rate estimate were computed by:

$$\overline{X} \pm t \; S/ \quad n$$

where, $\overline{X}$ is the average emission rate, S is the standard deviation of the emission rate values, n is the number of emission rate values and t is a tabulated statistical value (95% confidence level with n-1 degrees of freedom).

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CALCULATION SHEET

CALC. NO. ______

SIGNATURE ______ DATE JULY 30, 1985 CHECKED ______ DATE ______

PROJECT EPA - UPJOHN JOB NO. ______

SUBJECT INPUT VARIABILITIES SHEET 3 OF 5 SHEETS

ESTIMATED STANDARD DEVIATION AND STANDARD ERROR (CONT.)

MEASURED VALUES SUCH AS LENGTH (i.e. DUCT OR CARBON BED DIAMETER) AND SPECIFIC GRAVITY WILL HAVE AN ASSUMED 95% CONFIDENCE LIMIT OF ± 3% AND A STANDARD ERROR OF ±1.5%.

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CALCULATION SHEET

CALC. NO.

SIGNATURE DATE JULY 30, 1985 CHECKED DATE

PROJECT EPA - UPJOHN JOB NO.

SUBJECT INPUT VARIABILITIES SHEET 4 OF 5 SHEETS

STREAM VALUES USED IN VARIABILITY INVESTIGATION - FLOWRATE

STREAM	AVERAGE FLOWRATE, l/MIN	STANDARD DEVIATION	NUMBER OF OBSERVATIONS
PRIMARY CLARIFIER FEED	1080	303	72
PRIMARY CLARIFIER UNDERFLOW	238	36.1	72
RECYCLE TO PRIMARY CLARIFIER	37.8[a]	—	—
PROCESS WATER TO BELT FILTER	37.8[a]	—	—
SECONDARY CLARIFIER #2 FEED	861	107	72
SECONDARY CLARIFIER #2 UNDERFLOW	365	26.5	72
EXCESS CENTRIFUGE FEED	57[a]	—	—
SECONDARY CLARIFIER #3 FEED	793	151	72
SECONDARY CLARIFIER #3 UNDERFLOW	568	64.3	72
CARBON ADSORBER OUTLET	8.78 m/sec	0.177	5

[a] PLANT ESTIMATE

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CALCULATION SHEET

CALC. NO.

SIGNATURE (by NET) DATE JULY 30, 1985 CHECKED DATE

PROJECT EPA - UPJOHN JOB NO.

SUBJECT INPUT VARIABILITIES SHEET 5 OF 5 SHEETS

STREAM VALUES USED IN VARIABILITY INVESTIGATION

WEIGHT PERCENT SOLIDS

STREAM	AVERAGE WT. % SOLIDS	STANDARD DEVIATION	NUMBER OF OBSERVATIONS
PRIMARY CLARIFIER UNDERFLOW	12.6	—	1
SECONDARY CLARIFIER FEED	2.2	0	2
SECONDARY CLARIFIER #2 UNDERFLOW	3.8	—	1
FILTER BELT SOLIDS	16.4	0.495	2
SOUTH CENTRIFUGE SOLIDS	14.6	0.071	2
NORTH CENTRIFUGE SOLIDS	10.2	0	2

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CALCULATION SHEET

CALC. NO. ______
SIGNATURE Thomas P. Nelson (by WET) DATE 7/31/85 CHECKED ______ DATE ______
PROJECT EPA - UPJOHN JOB NO. ______
SUBJECT MATERIAL BALANCE AROUND PLANT - UNCERTAINTY SHEET 3 OF 3 SHEETS

OVERALL TNMHC BALANCE AROUND WWT PLANT

INLET

◇1 PRIMARY CLARIFIER FEED, F
~~◇2 STREAM~~ → O
~~◇3 PROCESS WATER~~ → ° P

OUTLET

◇4 CARBON ADSORBER EXHAUST, E
◇5 FILTER BELT SLUDGE, FS
◇6 CENTRIFUGE SLUDGE, CS
◇7 WASTE WATER, W

CLARIFIER FEED, F

$F = \text{CLARIFIER OVERFLOW (CO)} + FS + \text{FILTRATE (PF)}$

$CO = [(1080 \pm 35.7) + (37.8 \pm 3.78) - (238 \pm 4.25)]$

$FS = FS$

$PF = (238 \pm 4.25) - (37.8 \pm 3.78) + (37.8 \pm 3.78) - FS$

CARBON ADSORBER EXHAUST, E

$$E = (8.78 \pm 0.079) \times [(0.457 \pm 0.002)^2 \times \pi/4] \ \text{m}^3/\text{sec}$$

$$\times\ 500\,^\circ\text{R} / (557 \pm 8.4)\,^\circ\text{R} \times 1.20\ \text{kg/m}^3 \times 60\ \text{sec/min}$$

$$\times\ 92\ \text{kg/kg-mole} \ / \ 28.4\ \text{kg/kg-mole}$$

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CALCULATION SHEET

CALC. NO. ____
SIGNATURE [illegible] P. Nelson (by NEG) DATE 7/31/85 CHECKED ____ DATE ____
PROJECT EPA - UPJOHN JOB NO. ____
SUBJECT WWT UNCERTAINTY SHEET 2 OF 3 SHEETS

FILTER BELT SLUDGE, FS

$$FS = [(238 \pm 4.25) - (37.8 \pm 3.78)] \times (1.075 \pm 0.016)$$

$$\times (0.126 \pm 0.0019)/(0.164 \pm 0.0035)/(1.104 \pm 0.017)$$

CENTRIFUGE SLUDGE, CS

$$CS = [(365 \pm 3.12) - (57 \pm 5.7)] \times (1.022 \pm 0.015)$$

$$\times [(0.146 \pm 0.0005) + (0.102 \pm 0)]/[2 \times (0.038 \pm 0.00057)]$$

$$/(1.075 \pm 0.016)$$

WASTEWATER, W

$$W = (861 \pm 12.6) - (365 \pm 3.12) + (793 \pm 17.8)$$

$$- (568 \pm 7.58)$$

% CLOSURE

$$= \left[\frac{E \times C_E + FS \times C_{FS} \pm CS \times C_{CS} \pm W \times C_W}{CO \times C_{CO} \pm FS \times C_{FS} \pm PF \times C_{PF}}\right] \times 100$$

WHERE

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CALCULATION SHEET

CALC. NO. ________

SIGNATURE ________ DATE 7/31/85 CHECKED ________ DATE ________

PROJECT EPA - UPJOHN JOB NO. ________

SUBJECT WWT UNCERTAINTY SHEET 3 OF 3 SHEETS

	C_E	C_{FS}	C_{CS}	C_W	C_{CO}	C_{PF}
THC ($\times 10^6$)	450 ± 124	1460 ± 857	164 ± 70.4	56.5 ± 5.99	156 ± 29.1	156 ± 29.1
PARAFFINS ($\times 10^6$)	76.6 ± 46.4	714 ± 646	74 ± 31.4	17.8 ± 3.8	17.7 ± 3.96	17.7 ± 3.96
AROMATICS ($\times 10^6$)	53.5 ± 18.2	401 ± 152	50.5 ± 26.1	9.66 ± 7.77	80.3 ± 16.3	80.3 ± 16.3
HALOGENS ($\times 10^6$)	308 ± 50.6	237 ± 42.5	15.9 ± 6.15	5.15 ± 0.96	56.4 ± 8.17	56.4 ± 8.17

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CALCULATION SHEET

CALC. NO. ______

SIGNATURE Thomas P Nelson (by act) DATE JULY 30, 1985 CHECKED ______ DATE ______

PROJECT EPA - UPJOHN JOB NO. ______

SUBJECT INPUT VARIABILITIES SHEET 1 OF 5 SHEETS

STREAM VALUES USED IN VARIABILITY INVESTIGATION

HYDROCARBON CONCENTRATIONS

STREAM	ORGANIC CONCENTRATIONS								NUMBER OF OBSERVATIONS
	PARAFFINS	ST. DEV.	AROMATICS	ST. DEV.	HALOGENS	ST. DEV.	THC	ST. DEV.	
PRIMARY CLARIFIER OVERFLOW, mg/l	15.8	7.84	87.9	42.7	79.9	60.0	185	95.8	9
SECONDARY CLARIFIER FEED, mg/l	17.8	7.59	9.66	15.5	5.15	1.96	36.5	10.9	4
FILTRATE/CENTRIFUGATE, mg/l	16.3	5.26	12.6	12.5	5.00	0.60	36.5	10.9	3
SOUTH CENTRIFUGE SLUDGE, mg/g	121	62.5	64.2	71.9	21.3	18.1	248	165	2
NORTH CENTRIFUGE SLUDGE, mg/g	27.1	17.3	36.9	47.4	10.5	3.13	84.0	75.0	2
FILTER BELT SLUDGE, mg/g	744	914	401	214	237	60.1	1460	1210	2
CARBON ADSORBER INLET, ppm	75.5	74.1	53.8	55.8	241	66.0	392	196	3
CARBON ADSORBER OUTLET, ppm	76.6	80.4	53.5	31.6	308	82.7	450	215	3

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CALCULATION SHEET

CALC. NO.	
SIGNATURE	
DATE	JULY 30, 1985
CHECKED	
DATE	
PROJECT	EPA - UPJOHN
JOB NO.	
SUBJECT	INPUT VARIABILITIES
SHEET	2 OF 5 SHEETS

ESTIMATED STANDARD DEVIATION AND STANDARD ERROR

FOR VALUES ESTIMATED BY THE PLANT, THE 95% CONFIDENCE LIMITS ARE ESTIMATED AT ± 20%. THEREFORE, THE FOLLOWING RESULTS ARE GIVEN:

STREAM	AVERAGE FLOWRATE, ℓ/MIN	95% CONF. LIMITS	STANDARD ERROR
RECYCLE TO PRIMARY CLARIFIER	37.8	7.56	3.78
PROCESS WATER TO BELT FILTER	37.8	7.56	3.78
EXCESS CENTRIFUGE FEED	57	11.4	5.7
CARBON ABSORBER CONDENSATE	15	3.0	1.5

FOR THE WEIGHT PERCENT SOLID VALUES, WHERE ONLY ONE MEASUREMENT WAS MADE, THE CONFIDENCE LIMIT WAS BASED ON THE LARGEST STANDARD DEVIATION OF THE DUPLICATE SAMPLES (i.e. THE FILTER BELT SOLIDS).

$$\text{95\% CONF. LIMIT} = \text{ST. DEV.}/\text{VALUE} \times 100$$
$$= 0.495/16.4 \times 100$$
$$= 3.0$$

THEREFORE, THE FOLLOWING ESTIMATES ARE MADE:

STREAM	AVERAGE WT. % SOLIDS	95% CONF. LIMITS	STANDARD ERROR
PRIMARY CLARIFIER UNDERFLOW	12.6	0.38	0.19
SECONDARY CLARIFIER #2 UNDERFLOW	3.8	0.11	0.057

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```
                    UPJOHN MATERIAL BALANCE        16:45 MONDAY, APRIL 14, 1986    2
                      AROUND WWT PLANT

             (95% CONFIDENCE INTERVAL FOR % CLOSURE)


 SPECIES        CLOSURE      LOWER95      UPPER95    Relative Standard
                (%)                                  Error (%)

AROMATICS        63.114       37.282       81.570    18
HALOGENS        143.982      110.527      191.418    14
PARAFFINS       113.732       96.278      344.358    47
THC             104.959       82.842      142.438    14
```

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CALCULATION SHEET

CALC. NO.
SIGNATURE Thomas P Nelson DATE 7-31-85 CHECKED DATE
PROJECT EPA / UPJOHN JOB NO.
SUBJECT MATL Balance Around Lagoon Uncertainty SHEET 1 OF 3 SHEETS

OVERALL TNMHC Balance Around Lagoon

INLET

① Primary clarifier overflow, O
② carbon ADsorber condensate, C
③ clarifier #3 underflow, L
④ Excess centrifuge Feed, X
⑤ Filtrate / centrifugate, B

OUTLET

⑥ Carbon ADsorber Exhaust
⑦ #2 + #3 clarifier Feed, F

Clarifier overflow, O

O = Feed + Recycle − underflow
= (1080 ± 35.7) + (37.8 ± 3.78) − (238 ± 4,25)

Carbon ADsorber condensate, C

C = 15 ± 1,5

Clarifier #3 underflow, L

L = 568 ± 7,58

Excess centrifuge Feed, X

X = 57 ± 5,7

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CALCULATION SHEET

CALC. NO. ____
SIGNATURE Thomas P Nelson DATE 7-31-85 CHECKED ____ DATE ____
PROJECT EPA / UPJohn JOB NO. ____
SUBJECT Lagoon - Uncertainty SHEET 2 OF 3 SHEETS

Filtrate / centrifugate, B

$$\begin{aligned} B = {} & \left[(365 \pm 3.12) - (57 \pm 5.7)\right] - \Big\{\left[(365 \pm 3.12) - (57 \pm 5.7)\right] \\ & \times (1.022 \pm 0.015) / (1.075 \pm 0.016) \\ & / \left[(0.146 \pm 0.0005) + (0.102 \pm 0)\right] \times \left[2 \times (0.038 \pm 0.0057)\right]\Big\} \\ & + \left[(238 \pm 4.25) - (37.8 \pm 3.78)\right] - \Big\{\left[(238 \pm 4.25) - (37.8 \pm 3.78)\right] \\ & \times (1.075 \pm 0.016) / (1.04 \pm 0.017) \\ & \times (0.126 \pm 0.19) / (0.164 \pm 0.0035)\Big\} \\ & + (37.8 \pm 3.78) \end{aligned}$$

Carbon Adsorber Exhaust, E

$$E = (8.78 \pm 0.079) \times \left[(0.457 \pm 0.007)^2 \times \pi/4\right] \text{ m}^3\text{sec}$$

$$\times 520\,°R / (557 \pm 84)\,°R \times 1.20 \text{ kg/m}^3 \times 60 \text{ sec/min}$$

$$\times 92 \text{ kg/kg-mole} / 28.4 \text{ kg/kg-mole}$$

Feed to Secondary clarifiers, F

$$F = (861 \pm 12.6) + (793 \pm 17.8)$$

Biological oxidation

$$= O \times C_O + \cancelto{0}{C \times C_C} + L \times C_L + X\,C_X + B_X\,C_R$$

$$- (E_X C_E + F_X C_F)$$

where:

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CALCULATION SHEET

CALC. NO. ______
SIGNATURE ______ DATE 7-31-85 CHECKED ______ DATE ______
PROJECT EPA - UPJohn JOB NO. ______
SUBJECT Material Balance Around Lagoon Variability SHEET 3 OF 3 SHEETS

	C_o	C_c	C_L	C_x	C_B	C_E	C_F
THC (x 10^6)	185 ± 31.9	NA	36.4 ± 5.44	36.5 ± 5.44	34.5 ± 6.29	392 ± 113	36.5 ± 5.44
Paraffins (x 10^6)	15.9 ± 2.61	NA	17.8 ± 3.8	17.8 ± 3.8	16.3 ± 3.04	75.5 ± 416	17.8 ± 3.8
Aromatics (x 10^6)	87.4 ± 14.2	NA	9,66 ± 7.77	9,66 ± 7.77	12,6 ± 2.24	53.8 ± 32.2	9.66 ± 7.77
Halogens (x 10^6)	79.9 ± 20.0	NA	5,15 ± 0.98	5,15 ± 0.98	5.00 ± 0.35	261 ± 38.1	5.15 ± 0.98

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```
                    UPJOHN MATERIAL BALANCE        18:45 MONDAY, APRIL 14, 1986   20
                       AROUND THE LAGOON

          (95% CONFIDENCE INTERVAL FOR BIOLOGICAL OXIDATION)

                                                                   Relative Standard
             SPECIES        BIOLOGICAL      LOWER95      UPPER95   Error (%)
                            OXIDATION
                             mg/min

            AROMATICS          62120         25332        96481     50
            HALOGENS           -8298        -56360        36041    209
            PARAFFINS         -21609        -48382         2214     62
            THC                29743        -70596       127355    172
```

Appendix E
Thibodeaux-Parker-Heck Model And Modeling Results

TABLE E-1. EMISSION LOSSES FROM AERATED SURFACE IMPOUNDMENTS

Model:	Thibodeaux, Parker, and Heck
Disposal Method:	Surface Impoundment
Type of Model:	Predictive
Basis:	Mass transport theory concepts, with individual mass transfer coefficients obtained through the two resistance theory

Form:

$$q_i = M_i K_{li} (X_i - X_i^*)$$

and, for each volatile component i

$$K_l = (K_l^t A_t + K_l^n A_n)/(A_t + A_n)$$

$$\frac{1}{K^t} = \frac{1}{k^t} + \frac{1}{Hk_g^t}$$

$$\frac{1}{K_l^n} = \frac{1}{k_l^n} + \frac{1}{Hk_g^n}$$

Symbol	Symbol/Parameter Definition	Source of Input Parameters
q_i	Flux of component i from the impoundment surface, g/cm^2-sec	--
M_i	Molecular weight of component i, g/g-mol	Published Data
K_{li}	Overall liquid-phase mass transfer coefficient for component i, mol/cm^2-sec	Calculation
X_i	Mole fraction of component i in the aqueous phase	Measured
X_i^*	Mole fraction of component i in equilibrium with the mole fraction of component i in the air, y_i. If y_i is assumed to be negligibly small, $X_i^* = 0$.	Calculated from measured concentrations in the atmosphere
K_l^t, K_l^n	Overall liquid-phase mass transfer coefficients for the turbulent (aerated) and natural (unaerated) zones of the impoundment, respectively, mol/cm^2-sec	Calculated

(Continued)

TABLE E-1. (Continued)

Symbol	Symbol/Parameter Definition	Source of Input Parameters
A_t, A_n	Surface areas of the turbulent and natural zones, respectively, cm^2	Measured
k_l^t, k_l^n	Individual liquid phase mass transfer coefficients for the turbulent and natural zones, respectively, mol/cm -sec	Calculated from empirical correlations*
k_g^t, k_g^n	Individual gas phase mass transfer coefficients for the turbulent and natural zones, respectively, mol/cm -sec	Calculated from empirical correlations*
H	Henry's law constant in mole fraction form, y = Hx	Published data or estimation

*Empirical Correlation for Individual Mass Transfer Coefficients are shown below

$$k_l^t = \frac{0.823\ J\ (POWR)\ \alpha\ (1.024)^{\Theta-20}}{a_v V} \left(\frac{D_{iw}}{D_{O_2 w}}\right)^{0.5} \qquad \text{(a)}$$

$$k_g^t = 1.35\times10^{-5}\ \frac{\rho g\ D_{iw}}{d}\ N_{Re}^{1.42}\ N_p^{0.40}\ N_{Sc}^{0.5} N_{Fr}^{-0.21}$$

N_{Re} Reynolds Number, $\rho g\ d^2\ \omega / \mu g$

N_p Power Number, $P_r g_c / \rho \ell\ d^3 \omega^3$

N_{Sc} Schmidt Number, $\mu g / D_{i,\ air}\ \rho g$

N_{Fr} Froude Number, $d \omega^2 / gc$

$$k_l^n = 4.24\times10^{-4}\ (1.024)^{\Theta-20} U_o^{-0.67} H_o^{-0.85}\ \frac{D_{iw}}{D_{O_2 w}}$$

$$k_g^n = 1.30\times10^{-5} U_{air}^{0.78} N_{Sc}^{-0.67} d_e^{-0.11}\ \frac{\rho g}{MW_{air}}$$

(Continued)

TABLE E-1. (Continued)

Notation for Variables in Empirical Correlations

J	Oxygen-transfer rating of surface aerator, normally in the range of about 2-4 lb O_2/hr-hp
POWR	total power input to aerators in aerated surface impoundment, Hp
	correction factor for wastewater/clean water oxygen transfer (0.80 to 0.85)
Θ	water temperature, °C
D_{iw}	diffusion coefficient for component i in water, cm^2/sec
DO_{2w}	diffusion coefficient for oxygen in water, cm^2/sec
a_v	surface area per unit of volume of surface impoundment, ft^{-1}
V	volume of surface impoundment in region affected by aeration, ft^3
ρg	density of air, lb/ft^3 (gr/cm^3 in Eq. b)
$D_{i,\ air}$	diffusion coefficient for component i in air, cm^2/sec
d	diameter of aerator turbine or impeller, ft (cm in Eq. b)
ω	rotational speed of turbine impeller, rad/sec
μg	viscosity of air, g/cm-sec
P_r	power to impeller, ft-lb force/sec
G_c	gravitational constant, 32.2 ft/sec^2
$\rho \ell$	density of liquid, lb/ft^3
U_o	surface velocity, ft/sec
H_o	effective depth of surface impoundment, ft
U_{air}	wind speed, m/hr
d_e	effective diameter of quiescent area of surface impoundment, m
MW_{air}	molecular weight of air, lb/lb-mole

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS
CASE NO.: UPJOHN 1
COMPOUND: TOLUENE
INPUT DATA                           UNITS
----------------------------------------------------------------------
QUIESCENT SURFACE AREA,AN            M2                            3000
TURBULENT SURFACE AREA,AT            M2                            2940
EQUILIBRIUM CONSTANT,K               -                              442
MOLECULAR WEIGHT,MWI                 -                               92
COMPONENT AQUEOUS PHASE CONC,XI      MG/L                          0.28
COMPONENT GASEOUS PHASE CONC,YI      PPM                           34.3
GAS PHASE WATER FRACTION,YW          -                           0.0476
DIFFUSIVITY IN WATER,DIW             CM2/SEC                 0.00000934
DIFFUSIVITY OF O2 IN WATER,DO2W      CM2/SEC                  0.0000247
WINDSPEED,UAIR                       M/S                         0.0559
SURFACE VELOCITY,UO                  M/S                      0.0019565
EFFECTIVE IMPOUNDMENT DEPTH,HO       M                            0.549
VISCOSITY OF AIR,UG                  CP                          0.0184
VAPOR DENSITY OF AIR,PG              G/CM3                      0.00126
DIFFUSIVITY OF COMPOUND IN AIR,DIA   CM2/SEC                     0.0883
MOLECULAR WEIGHT OF AIR,MWAIR        G/GMOLE                         29
WATER TEMPERATURE,TW                 C                               33
OXYGEN TRANSFER RATE FOR AERATOR,J   LB O2/HR-HP                      2
TOTAL POWER INPUT TO AERATORS,POWR   HP                             270
CORRECTION FACTOR FOR O2 TRANSFER,@  -                            0.825
LAGOON AREA PER UNIT VOLUME,aV       ft-1                         0.555
VOLUME OF IMPOUNDMENT AERATED,V      ft3                          57000
DIAMETER OF AERATOR IMPELLER,d       ft                               2
ROTATIONAL SPEED OF IMPELLER,w       RAD/SEC                        191
POWER TO IMPELLER,PR                 FT-LBf/SEC                   35062
GRAVITATIONAL CONSTANT,gc            FT/SEC2                       32.2
DENSITY OF LIQUID,pL                 LB/FT3                       62.23

----------------------------------------------------------------------

MISCELLANEOUS CALCULATIONS
  SCHMIDT NO.                                                     1.654
  REYNOLDS NO.                                                 4.86E+06
  POWER NO.                                                       0.303
  FROUDE NO.                                                       2266
  EFFECTIVE DIAMETER                 M                             61.8
----------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL (CONTINUED)
CASE NO.: UPJOHN 1
COMPOUND: TOLUENE
-------------------------------

RESULTS
-----------------------------------------------------------
QUIESCENT LIQUID FILM kL       GMOL/CM2-S          4.49E-06
QUIESCENT GAS FILM kG          GMOL/CM2-S          1.00E-06

OVERALL QUIESCENT KN           GMOL/CM2-S          4.45E-06

TURBULENT LIQUID FILM kL       GMOL/CM2-S          9.70E-03
TURBULENT GAS FILM kG          GMOL/CM2-S          9.04E-02

OVERALL TURBULENT KT           GMOL/CM2-S          9.70E-03

TOTAL EMISSION RATE,QI         G/SEC              -5.02E-01
                               LB/HR              -3.98E+00
-----------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS
CASE NO.: UPJOHN 1
COMPOUND: BENZENE
INPUT DATA                          UNITS
--------------------------------------------------------------------
QUIESCENT SURFACE AREA,AN           M2                          3000
TURBULENT SURFACE AREA,AT           M2                          2940
EQUILIBRIUM CONSTANT,K              -                            378
MOLECULAR WEIGHT,MWI                -                           78.1
COMPONENT AQUEOUS PHASE CONC,XI     MG/L                         0.6
COMPONENT GASEOUS PHASE CONC,YI     PPM                         17.2
GAS PHASE WATER FRACTION,YW         -                         0.0476
DIFFUSIVITY IN WATER,DIW            CM2/SEC                0.0000106
DIFFUSIVITY OF O2 IN WATER,DO2W     CM2/SEC                0.0000247
WINDSPEED,UAIR                      M/S                       0.0559
SURFACE VELOCITY,UO                 M/S                    0.0019565
EFFECTIVE IMPOUNDMENT DEPTH,HO      M                          0.549
VISCOSITY OF AIR,UG                 CP                        0.0184
VAPOR DENSITY OF AIR,PG             G/CM3                    0.00126
DIFFUSIVITY OF COMPOUND IN AIR,DIA  CM2/SEC                    0.097
MOLECULAR WEIGHT OF AIR,MWAIR       G/GMOLE                       29
WATER TEMPERATURE,TW                C                             33
OXYGEN TRANSFER RATE FOR AERATOR,J  LB O2/HR-HP                    2
TOTAL POWER INPUT TO AERATORS,POWR  HP                           270
CORRECTION FACTOR FOR O2 TRANSFER,@ -                          0.825
LAGOON AREA PER UNIT VOLUME,aV      ft-1                       0.555
VOLUME OF IMPOUNDMENT AERATED,V     ft3                        57000
DIAMETER OF AERATOR IMPELLER,d      ft                             2
ROTATIONAL SPEED OF IMPELLER,w      RAD/SEC                      191
POWER TO IMPELLER,PR                FT-LBf/SEC                 35062
GRAVITATIONAL CONSTANT,gc           FT/SEC2                     32.2
DENSITY OF LIQUID,pL                LB/FT3                     62.23

--------------------------------------------------------------------
MISCELLANEOUS CALCULATIONS
  SCHMIDT NO.                                                  1.505
  REYNOLDS NO.                                              4.86E+06
  POWER NO.                                                    0.303
  FROUDE NO.                                                    2266
  EFFECTIVE DIAMETER                M                           61.8
--------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL (CONTINUED)
CASE NO.: UPJOHN 1
COMPOUND: BENZENE
-------------------------------------

RESULTS
----------------------------------------------------------------------
QUIESCENT LIQUID FILM kL             GMOL/CM2-S             5.10E-06
QUIESCENT GAS FILM kG                GMOL/CM2-S             1.07E-06

OVERALL QUIESCENT KN                 GMOL/CM2-S             5.03E-06

TURBULENT LIQUID FILM kL             GMOL/CM2-S             1.03E-02
TURBULENT GAS FILM kG                GMOL/CM2-S             9.47E-02

OVERALL TURBULENT KT                 GMOL/CM2-S             1.03E-02

TOTAL EMISSION RATE,QI               G/SEC                  2.25E+00
                                     LB/HR                  1.79E+01
----------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS
CASE NO.: UPJOHN 1
COMPOUND: 1,2-DICHLOROETHANE
INPUT DATA                          UNITS
--------------------------------------------------------------------
QUIESCENT SURFACE AREA,AN           M2                          3000
TURBULENT SURFACE AREA,AT           M2                          2940
EQUILIBRIUM CONSTANT,K              -                           85.5
MOLECULAR WEIGHT,MWI                -                             99
COMPONENT AQUEOUS PHASE CONC,XI     MG/L                         4.2
COMPONENT GASEOUS PHASE CONC,YI     PPM                        205.3
GAS PHASE WATER FRACTION,YW         -                         0.0476
DIFFUSIVITY IN WATER,DIW            CM2/SEC                0.0000101
DIFFUSIVITY OF O2 IN WATER,DO2W     CM2/SEC                0.0000247
WINDSPEED,UAIR                      M/S                       0.0559
SURFACE VELOCITY,UO                 M/S                    0.0019565
EFFECTIVE IMPOUNDMENT DEPTH,HO      M                          0.549
VISCOSITY OF AIR,UG                 CP                        0.0184
VAPOR DENSITY OF AIR,PG             G/CM3                    0.00126
DIFFUSIVITY OF COMPOUND IN AIR,DIA  CM2/SEC                   0.0944
MOLECULAR WEIGHT OF AIR,MWAIR       G/GMOLE                       29
WATER TEMPERATURE,TW                C                             33
OXYGEN TRANSFER RATE FOR AERATOR,J  LB O2/HR-HP                    2
TOTAL POWER INPUT TO AERATORS,POWR  HP                           270
CORRECTION FACTOR FOR O2 TRANSFER,@ -                          0.825
LAGOON AREA PER UNIT VOLUME,aV      ft-1                       0.555
VOLUME OF IMPOUNDMENT AERATED,V     ft3                        57000
DIAMETER OF AERATOR IMPELLER,d      ft                             2
ROTATIONAL SPEED OF IMPELLER,w      RAD/SEC                      191
POWER TO IMPELLER,PR                FT-LBf/SEC                 35062
GRAVITATIONAL CONSTANT,gc           FT/SEC2                     32.2
DENSITY OF LIQUID,pL                LB/FT3                     62.23

--------------------------------------------------------------------
MISCELLANEOUS CALCULATIONS
  SCHMIDT NO.                                                  1.547
  REYNOLDS NO.                                              4.86E+06
  POWER NO.                                                    0.303
  FROUDE NO.                                                    2266
  EFFECTIVE DIAMETER                M                           61.8
--------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL (CONTINUED)
CASE NO.: UPJOHN 1
COMPOUND: 1,2-DICHLOROETHANE


RESULTS
--------------------------------------------------------------------
QUIESCENT LIQUID FILM kL           GMOL/CM2-S             4.86E-06
QUIESCENT GAS FILM kG              GMOL/CM2-S             1.05E-06

OVERALL QUIESCENT KN               GMOL/CM2-S             4.61E-06

TURBULENT LIQUID FILM kL           GMOL/CM2-S             1.01E-02
TURBULENT GAS FILM kG              GMOL/CM2-S             9.35E-02

OVERALL TURBULENT KT               GMOL/CM2-S             1.01E-02

TOTAL EMISSION RATE,QI             G/SEC                 -4.47E+01
                                   LB/HR                 -3.54E+02
--------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS
CASE NO.: UPJOHN 2
COMPOUND: PARAFFINS
INPUT DATA                             UNITS
-----------------------------------------------------------------------------
QUIESCENT SURFACE AREA,AN              M2                            3000
TURBULENT SURFACE AREA,AT              M2                            2940
EQUILIBRIUM CONSTANT,K                 -                            55600
MOLECULAR WEIGHT,MWI                   -                             62.9
COMPONENT AQUEOUS PHASE CONC,XI        MG/L                         17.78
COMPONENT GASEOUS PHASE CONC,YI        PPM                           75.5
GAS PHASE WATER FRACTION,YW            -                           0.0476
DIFFUSIVITY IN WATER,DIW               CM2/SEC                 0.00000963
DIFFUSIVITY OF O2 IN WATER,DO2W        CM2/SEC                  0.0000247
WINDSPEED,UAIR                         M/S                         0.0559
SURFACE VELOCITY,U0                    M/S                      0.0019565
EFFECTIVE IMPOUNDMENT DEPTH,HO         M                            0.549
VISCOSITY OF AIR,UG                    CP                          0.0184
VAPOR DENSITY OF AIR,PG                G/CM3                      0.00126
DIFFUSIVITY OF COMPOUND IN AIR,DIA     CM2/SEC                      0.088
MOLECULAR WEIGHT OF AIR,MWAIR          G/GMOLE                         29
WATER TEMPERATURE,TW                   C                               33
OXYGEN TRANSFER RATE FOR AERATOR,J     LB O2/HR-HP                      2
TOTAL POWER INPUT TO AERATORS,POWR     HP                             270
CORRECTION FACTOR FOR O2 TRANSFER,θ    -                            0.825
LAGOON AREA PER UNIT VOLUME,aV         ft-1                         0.555
VOLUME OF IMPOUNDMENT AERATED,V        ft3                          57000
DIAMETER OF AERATOR IMPELLER,d         ft                               2
ROTATIONAL SPEED OF IMPELLER,w         RAD/SEC                        191
POWER TO IMPELLER,PR                   FT-LBf/SEC                   35062
GRAVITATIONAL CONSTANT,gc              FT/SEC2                       32.2
DENSITY OF LIQUID,pL                   LB/FT3                       62.23

-----------------------------------------------------------------------------
MISCELLANEOUS CALCULATIONS
  SCHMIDT NO.                                                       1.659
  REYNOLDS NO.                                                   4.86E+06
  POWER NO.                                                         0.303
  FROUDE NO.                                                         2266
  EFFECTIVE DIAMETER                   M                             61.8
-----------------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL (CONTINUED)
CASE NO.: UPJOHN 2
COMPOUND: PARAFFINS


RESULTS
---------------------------------------------------------------------
QUIESCENT LIQUID FILM kL          GMOL/CM2-S            4.63E-06
QUIESCENT GAS FILM kG             GMOL/CM2-S            9.99E-07

OVERALL QUIESCENT KN              GMOL/CM2-S            4.63E-06

TURBULENT LIQUID FILM kL          GMOL/CM2-S            9.85E-03
TURBULENT GAS FILM kG             GMOL/CM2-S            9.02E-02

OVERALL TURBULENT KT              GMOL/CM2-S            9.85E-03

TOTAL EMISSION RATE,QI            G/SEC                 9.27E+01
                                  LB/HR                 7.35E+02
---------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS
CASE NO.: UPJOHN 2
COMPOUND: AROMATICS
INPUT DATA                           UNITS
------------------------------------------------------------------------
QUIESCENT SURFACE AREA,AN            M2                             3000
TURBULENT SURFACE AREA,AT            M2                             2940
EQUILIBRIUM CONSTANT,K               -                               385
MOLECULAR WEIGHT,MWI                 -                                83
COMPONENT AQUEOUS PHASE CONC,XI      MG/L                           9.66
COMPONENT GASEOUS PHASE CONC,YI      PPM                            53.8
GAS PHASE WATER FRACTION,YW          -                            0.0476
DIFFUSIVITY IN WATER,DIW             CM2/SEC                   0.0000103
DIFFUSIVITY OF O2 IN WATER,DO2W      CM2/SEC                   0.0000247
WINDSPEED,UAIR                       M/S                          0.0559
SURFACE VELOCITY,UO                  M/S                       0.0019565
EFFECTIVE IMPOUNDMENT DEPTH,HO       M                             0.549
VISCOSITY OF AIR,UG                  CP                           0.0184
VAPOR DENSITY OF AIR,PG              G/CM3                       0.00126
DIFFUSIVITY OF COMPOUND IN AIR,DIA   CM2/SEC                      0.0935
MOLECULAR WEIGHT OF AIR,MWAIR        G/GMOLE                          29
WATER TEMPERATURE,TW                 C                                33
OXYGEN TRANSFER RATE FOR AERATOR,J   LB O2/HR-HP                       2
TOTAL POWER INPUT TO AERATORS,POWR   HP                              270
CORRECTION FACTOR FOR O2 TRANSFER,@ -                              0.825
LAGOON AREA PER UNIT VOLUME,aV       ft-1                          0.555
VOLUME OF IMPOUNDMENT AERATED,V      ft3                           57000
DIAMETER OF AERATOR IMPELLER,d       ft                                2
ROTATIONAL SPEED OF IMPELLER,w       RAD/SEC                         191
POWER TO IMPELLER,PR                 FT-LBf/SEC                    35062
GRAVITATIONAL CONSTANT,gc            FT/SEC2                        32.2
DENSITY OF LIQUID,pL                 LB/FT3                        62.23

------------------------------------------------------------------------
MISCELLANEOUS CALCULATIONS
  SCHMIDT NO.                                                      1.562
  REYNOLDS NO.                                                  4.86E+06
  POWER NO.                                                        0.303
  FROUDE NO.                                                        2266
  EFFECTIVE DIAMETER                 M                              61.8
------------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL (CONTINUED)
CASE NO.: UPJOHN 2
COMPOUND: AROMATICS


RESULTS
---------------------------------------------------------------------
QUIESCENT LIQUID FILM kL         GMOL/CM2-S              4.95E-06
QUIESCENT GAS FILM kG            GMOL/CM2-S              1.04E-06

OVERALL QUIESCENT KN             GMOL/CM2-S              4.89E-06

TURBULENT LIQUID FILM kL         GMOL/CM2-S              1.02E-02
TURBULENT GAS FILM kG            GMOL/CM2-S              9.30E-02

OVERALL TURBULENT KT             GMOL/CM2-S              1.02E-02

TOTAL EMISSION RATE,QI           G/SEC                   4.88E+01
                                 LB/HR                   3.87E+02
---------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS
CASE NO.: UPJOHN 2
COMPOUND: HALOGENS
INPUT DATA                          UNITS
-------------------------------------------------------------------
QUIESCENT SURFACE AREA,AN           M2                          3000
TURBULENT SURFACE AREA,AT           M2                          2940
EQUILIBRIUM CONSTANT,K              -                            106
MOLECULAR WEIGHT,MWI                -                          103.7
COMPONENT AQUEOUS PHASE CONC,XI     MG/L                        5.15
COMPONENT GASEOUS PHASE CONC,YI     PPM                          261
GAS PHASE WATER FRACTION,YW         -                         0.0476
DIFFUSIVITY IN WATER,DIW            CM2/SEC               0.00000991
DIFFUSIVITY OF O2 IN WATER,DO2W     CM2/SEC                0.0000247
WINDSPEED,UAIR                      M/S                       0.0559
SURFACE VELOCITY,UO                 M/S                    0.0019565
EFFECTIVE IMPOUNDMENT DEPTH,HO      M                          0.549
VISCOSITY OF AIR,UG                 CP                        0.0184
VAPOR DENSITY OF AIR,PG             G/CM3                    0.00126
DIFFUSIVITY OF COMPOUND IN AIR,DIA  CM2/SEC                   0.0936
MOLECULAR WEIGHT OF AIR,MWAIR       G/GMOLE                       29
WATER TEMPERATURE,TW                C                             33
OXYGEN TRANSFER RATE FOR AERATOR,J  LB O2/HR-HP                    2
TOTAL POWER INPUT TO AERATORS,POWR  HP                           270
CORRECTION FACTOR FOR O2 TRANSFER,θ -                          0.825
LAGOON AREA PER UNIT VOLUME,aV      ft-1                       0.555
VOLUME OF IMPOUNDMENT AERATED,V     ft3                        57000
DIAMETER OF AERATOR IMPELLER,d      ft                             2
ROTATIONAL SPEED OF IMPELLER,w      RAD/SEC                      191
POWER TO IMPELLER,PR                FT-LBf/SEC                 35062
GRAVITATIONAL CONSTANT,gc           FT/SEC2                     32.2
DENSITY OF LIQUID,pL                LB/FT3                     62.23

-------------------------------------------------------------------
MISCELLANEOUS CALCULATIONS
  SCHMIDT NO.                                                  1.560
  REYNOLDS NO.                                              4.86E+06
  POWER NO.                                                    0.303
  FROUDE NO.                                                    2266
  EFFECTIVE DIAMETER                M                           61.8
-------------------------------------------------------------------
```

```
THIBODEAUX-PARKER-HECK EMISSIONS MODEL (CONTINUED)
CASE NO.: UPJOHN 2
COMPOUND: HALOGENS


RESULTS
--------------------------------------------------------------------
QUIESCENT LIQUID FILM kL            GMOL/CM2-S              4.77E-06
QUIESCENT GAS FILM kG               GMOL/CM2-S              1.04E-06

OVERALL QUIESCENT KN                GMOL/CM2-S              4.57E-06

TURBULENT LIQUID FILM kL            GMOL/CM2-S              9.99E-03
TURBULENT GAS FILM kG               GMOL/CM2-S              9.31E-02

OVERALL TURBULENT KT                GMOL/CM2-S              9.98E-03

TOTAL EMISSION RATE,QI              G/SEC                  -4.42E+01
                                    LB/HR                  -3.50E+02
--------------------------------------------------------------------
```

RADIAN
CORPORATION

```
                                UPJOHN                        12:18 TUESDAY, APRIL 15, 1986     3
             MODEL FOR CALCULATING SURFACE IMPOUNDMENT EMISSIONS
          (THIBODEAUX-PARKER-HECK EMISSIONS MODEL/AERATED IMPOUNDMENTS)

COMPOUND        EMISSION     LOWER95      UPPER95      EMISSION,     LOW95       UP95     Relative Standard
                RATE                                   RATE                                 Error (%)
                (G/SEC)                                (LB/HR)

AROMATICS         48.765       -4.933     143.956       386.69      -39.12     1134.37        82
BENZENE            2.250       -1.193       7.052        17.86       -9.46       55.92        91
HALOGENS         -44.193      -79.399     -17.954      -350.43     -629.52     -142.37        35
PARAFFINS         92.760       44.265     152.478       735.60      351.00     1298.37        32
TNMHC            192.337      108.823     324.560      1525.14      862.92     2573.61        26
TOLUENE           -0.502       -4.674       2.952        -3.98      -37.07       23.40       410
1,2-DCE          -44.554      -82.038     -21.598      -353.29     -650.52     -171.18        33
```

Appendix F
Fixed Roof Tank Emission Model
Breathing Losses

TABLE F-1. RECOMMENDED MODEL FOR FIXED ROOF TANK BREATHING LOSSES (TRW UPDATE OF 1962 API MODEL)

$$L_B = 2.26 \times 10^{-2} M \left[\frac{P}{14.7-P}\right]^{0.68} D^{1.73} H^{0.51} \Delta T^{0.50} F_P C K_C$$

where:

L_B = fixed roof breathing loss (lb/year)

M = molecular weight of vapor in storage tank (lb/lb mole). See AP-42, Table 4.3-1.

P = true vapor pressure at bulk liquid conditions (psia). See note 1.

D = tank diameter (ft).

H = average vapor space height, including roof volume correction (ft). See Note 2.

ΔT = average ambient diurnal temperature change (°F).

F_P = paint factor (dimensionless). See AP-42, Table 4.3-2.

C = adjustment factor for small diameter tanks (dimensionless). See AP-42, Figure 4.3-4.

K_C = product factor (dimensionless). See Note 3.

Notes: (1) True vapor pressures for organic liquids can be determined from AP-42, Figures 4.3-5 or 4.3-6, or AP-42, Table 4.3-1.

(2) The vapor space in a cone roof is equal in volume to a cylinder which has the same base diameter as the cone and is one third the height of the cone.

(3) For crude oil, K_C = 0.65. For all other organic liquids, K_C=1.0.

TABLE F-2. INPUT PARAMETERS AND RESULTS FOR BREATHING LOSS CALCULATION

```
API EMPIRICAL MODEL
CASE NO.: UPJOHN 1
COMPOUND: ALL
INPUT DATA                              UNITS
------------------------------------------------------------------
MOLECULAR WEIGHT OF VAPOR,MW            G/GMOLE               100
TRUE VAPOR PRESSURE,VP                  PSIA             0.000781
TANK DIAMETER,D                         FT                     14
AVE HEIGHT OF VAPOR SPACE,H             FT                      2
AVE DAILY AMBIENT DELTA T, T            F                      15
PAINT FACTOR                            -                     1.3
ADJUSTMENT FACTOR FOR SMALL TANKS,C     -                     0.7
CRUDE OIL FACTOR,KC                     -                       1
------------------------------------------------------------------

RESULTS
------------------------------------------------------------------

FIXED ROOF BREATHING LOSS,LB            LB/YEAR          1.04E+00
                                        LB/HR            1.19E-04
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Appendix G
Daily Log

Upjohn Tests: August 13-19, 1984

DAILY ACTIVITIES LOG

Monday, August 13

Mobile lab and equipment delayed on route. Bart Eklund and Tom Nelson (Radian) arrived on-site and toured facility with Larry Joffe (Upjohn). Examined sampling locations and began plant data acquisition.

Tuesday, August 14

Mobile lab and John Randall (Radian) arrived on-site at 6:00 p.m. Power was connected and equipment unpacked and sorted. Began assembling sample extraction system.

Wednesday, August 15

Ben Blaney (EPA) and Dave Taylor (S-Cubed) arrived on-site. The equipment set-up was completed and the preliminary quality control tests were run. Discussed sampling plans with Blaney and sample points and sampling frequency plans were finalized. One set of samples was collected in the afternoon. Byron semi-continuous analyzers were placed in-line at end of day.

Thursday, August 16

Completed all of day's scheduled activities. Collected numerous grab samples, performed velocity traverses, collected gas phase samples, and performed routine quality control checks on analyzers. Performed an emissions survey around the dome to estimate the volume and concentration of the fugitive emissions. In addition, began collecting samples at the 55 gallon drums of carbon. Process data collection continued on schedule.

Friday, August 17

Collected all scheduled samples and process data. Performed routine quality control checks.

Saturday, August 18

Collected all scheduled samples and process data. Performed routine quality control checks.

Sunday, August 19

Terminated gas-phase collection at approximately 0930 and performed final quality control checks. All equipment was packed and the trailer removed from the plant.

Appendix H
Sample Inventory

SAMPLE INVENTORY

Master Log #	Date Taken	Time	Sample Type	Location	Comments
U001	7-17-84	1425	Liquid	Primary Clarifier Overflow	Collected during Pretest Site Survey
U002	7-17-84	1425	Liquid	Primary Clarifier Overflow	Collected during Pretest Site Survey
U003	7-17-84	1425	Gas Canister	CAS Outlet	Collected during Pretest Site Survey
U004	7-17-84	1425	Gas Canister	CAS Inlet	Collected during Pretest Site Survey
U005	7-17-84	1425	Liquid	Secondary Clarifier Overflow	Collected during Pretest Site Survey
U006	7-17-84	1425	Liquid	Secondary Clarifier Overflow	Collected during Pretest Site Survey
U007	7-17-84	1425	Gas Canister	SE Corner Hatch	Collected during Pretest Site Survey
U008	7-17-84	1425	Gas Canister	SW Corner Hatch	Collected during Pretest Site Survey
U009	8-15-84	0900	Liquid	Primary Clarifier Overflow	
U010	8-15-84	1000	Liquid	Primary Clarifier Overflow	
U011	8-15-84	1100	Liquid	Primary Clarifier Overflow	
U012	8-15-84	1210	Liquid	Primary Clarifier Overflow	
U013	8-15-84	1300	Liquid	Primary Clarifier Overflow	
U014	8-15-84	1505	Liquid	Primary Clarifier Overflow	
U015	8-15-84	1625	Liquid	Primary Clarifier Overflow	
U016	8-15-84	1640	Slurry	Primary Clarifier Underflow	
U017	8-15-84	1652	Liquid	Lagoon Recycle from Solids Handling	
U018	8-15-84	1655	Slurry	South Centrifuge	
U019	8-15-84	1655	Slurry	North Centrifuge	
U020	8-15-84	1655	Slurry	Filter Belt	
U021	8-15-84	1735	Liquid	Secondary Clarifier Overflow	
U022	8-15-84	1735	Liquid	Secondary Clarifier Overflow	
U023	8-15-84	1740	Slurry	Secondary Clarifier Underflow	
U024	8-15-84	1800	Liquid	Primary Clarifier Overflow	
U025	8-16-84	0810	Liquid	Primary Clarifier Overflow	
U026	8-16-84	0825	Gas Canister	CAS Inlet	CAS = Carbon Adsorption System
U027	8-16-84	0825	Gas Canister	CAS Outlet	
U028	8-16-84	1045	Liquid	Primary Clarifier Overflow	Collected in Duplicate
U029	8-16-84	1100	Slurry	Primary Clarifier Underflow	Collected in Duplicate
U030	8-16-84	1115	Liquid	Secondary Clarifier Overflow	Collected in Duplicate

Master Log #	Date Taken	Time	Sample Type	Location	Comments
U031	8-16-84	1120	Slurry	Secondary Clarifier Feed	Collected in Duplicate
U032	8-16-84	1125	Slurry	Secondary Clarifier Underflow	Collected in Duplicate
U033	8-16-84	1135	Slurry	Lagoon Recycle from Solids Handling	Collected in Duplicate
U034	8-16-84	1140	Slurry	South Centrifuge	Collected in Duplicate
U035	8-16-84	1145	Slurry	North Centrifuge	Collected in Duplicate
U036	8-16-84	1150	Slurry	Filter Belt	Collected in Duplicate
U037	8-16-84	1205	Liquid	Primary Clarifier Overflow	Collected in Duplicate
U038	8-16-84	1315	Liquid	Primary Clarifier Overflow	
U039	8-16-84	1315	Slurry	Lagoon Recycle from Solids Handling	
U040	8-16-84	1325	Slurry	Secondary Clarifier Feed	
U041	8-16-84	1435	Liquid	Primary Clarifier Overflow	
U042	8-16-84	1450	Gas Canister	C.A.S. Inlet	
U043	8-16-84	1455	Gas Canister	C.A.S. Outlet	
U044	8-16-84	1520	Slurry	Secondary Clarifier Feed	
U045	8-16-84	1525	Slurry	Lagoon Recycle from Solids Handling	
U046	8-16-84	1530	Liquid	Primary Clarifier Overflow	
U047	8-16-84	1600	Slurry	South Centrifuge	
U048	8-16-84	1605	Slurry	North Centrifuge	
U049	8-16-84	1610	Slurry	Filter Belt	
U050	8-16-84	1625	Liquid	Secondary Clarifier Overflow	
U051	8-16-84	1630	Slurry	Secondary Clarifier Underflow	
U052	8-16-84	1645	Liquid	Primary Clarifier Overflow	
U053	8-16-84	1730	Liquid	Primary Clarifier Overflow	
U054	8-16-84	1740	Slurry	Lagoon Recycle from Solids Handling	
U055	8-16-84	1745	Slurry	Secondary Clarifier Feed	
U056	8-16-84	1735	Slurry	Primary Clarifier Underflow	
U057	8-16-84	1750	Gas Canister	CAS Inlet	
U058	8-16-84	1755	Gas Canister	CAS Outlet	
U059	8-17-84	0845	Gas Canister	CAS Inlet	
U060	8-17-84	0845	Gas Canister	CAS Outlet	
U061	8-17-84	0845	Liquid	Primary Clarifier Overflow	
U062	8-17-84	0845	Slurry	Primary Clarifier Underflow	Collected in duplicate
U063	8-17-84	0855	Slurry	Lagoon Recycle from Solids Handling	
U064	8-17-84	0900	Slurry	South Centrifuge	
U065	8-17-84	0905	Slurry	North Centrifuge	
U066	8-17-84	0907	Slurry	Filter Belt	
U067	8-17-84	0915	Liquid	Secondary Clarifier Overflow	
U068	8-17-84	0917	Slurry	Secondary Clarifier Feed	
U069	8-17-84	0920	Slurry	Secondary Clarifier Underflow	

Master Log #	Date Taken	Time	Sample Type	Location	Comments
U070	8-17-84	0950	Liquid	Primary Clarifier Overflow	
U071	8-17-84	1000	Gas Canister	Inlet Carbon Drum	16 hr integrated sample
U072	8-17-84	1000	Gas Canister	Outlet Carbon Drum	16 hr integrated sample
U073	8-17-84	1115	Liquid	Primary Clarifier Overflow	
U074	8-17-84	1120	Slurry	Lagoon Recycle from Solids Handling	
U075	8-17-84	1125	Slurry	Secondary Clarifier Feed	
U076	8-17-84	1145	Solid	Carbon from Bed	
U077	8-17-84	1200	Liquid	Primary Clarifier Overflow	
U078	8-17-84	1350	Liquid	Primary Clarifier Overflow	
U079	8-17-84	1404	Slurry	Lagoon Recycle from Solids Handling	
U080	8-17-84	1407	Slurry	Secondary Clarifier Feed	
U081	8-17-84	1420	Gas Canister	CAS Inlet	
U082	8-17-84	1425	Gas Canister	CAS Outlet	
U083	8-17-84	1455	Liquid	Primary Clarifier Overflow	
U084	8-17-84	1500	Slurry	Primary Clarifier Underflow	
U085	8-17-84	1605	Liquid	Primary Clarifier Overflow	
U086	8-17-84	1620	Slurry	Lagoon Recycle from Solids Handling	
U087	8-17-84	1623	Slurry	South Centrifuge	
U088	8-17-84	1625	Slurry	North Centrifuge	
U089	8-17-84	1627	Slurry	Filter Belt	
U090	8-17-84	1635	Slurry	Secondary Clarifier Feed	
U091	8-17-84	1637	Slurry	Secondary Clarifier Underflow	
U092	8-17-84	1635	Liquid	Secondary Clarifier Overflow	
U093	8-17-84	1645	Gas Canister	CAS Inlet	
U094	8-17-84	1642	Gas Canister	CAS Outlet	
U095	8-17-84	1700	Liquid	Primary Clarifier Overflow	
U096	8-18-84	0820	Liquid	Primary Clarifier Overflow	
U097	8-18-84	0848	Slurry	Lagoon Recycle from Solids Handling	
U098	8-18-84	0851	Slurry	Secondary Clarifier Feed	
U099	8-18-84	0908	Gas Canister	CAS Inlet	
U100	8-18-84	0907	Gas Canister	CAS Outlet	
U101	8-18-84	0917	Liquid	Primary Clarifier Overflow	
U102	8-18-84	0918	Slurry	Primary Clarifier Underflow	
U103	8-18-84	0940	Liquid	Secondary Clarifier Underflow	
U104	8-18-84	0938	Slurry	Secondary Clarifier Underflow	

Master Log #	Date Taken	Time	Sample Type	Location	Comments
U105	8-18-84	0953	Slurry	South Centrifuge	
U106	8-18-84	0955	Slurry	North Centrifuge	
U107	8-18-84	1000	Slurry	Filter Belt	
U108	8-18-84	0920	Solid	Carbon from 55 gal drum inlet	
U109	8-18-84	0935	Gas Canister	Carbon Drum Inlet	23 hr integrated sample
U110	8-18-84	0935	Gas Canister	Carbon Drum Outlet	23 hr integrated sample
U111	8-18-84	1030	Liquid	Primary Clarifier overflow	
U112	8-18-84	1032	Slurry	Lagoon Recycle from Solids Handling	
U113	8-18-84	1035	Slurry	Secondary Clarifier Feed	
U114	8-18-84	1152	Liquid	Primary Clarifier Overflow	
U115	8-18-84	1157	Slurry	Lagoon Recycle from Solids Handling	
U116	8-18-84	1200	Slurry	Secondary Clarifier Feed	
U117	8-18-84	1310	Liquid	Primary Clarifier Overflow	
U118	8-18-84	1351	Liquid	Primary Clarifier Overflow	
U119	8-18-84	1353	Slurry	Primary Clarifier Underflow	
U120	8-18-84	1400	Slurry	Lagoon Recycle from Solids Handling	
U121	8-18-84	1402	Slurry	South Centrifuge	
U122	8-18-84	1405	Slurry	North Centrifuge	
U123	8-18-84	1410	Slurry	Filter Belt	
U124	8-18-84	1415	Slurry	Secondary Clarifier Feed	
U125	8-18-84	1415	Liquid	Secondary Clarifier Overflow	
U126	8-18-84	1418	Slurry	Secondary Clarifier Underflow	
U127	8-18-84	1535	Liquid	Primary Clarifier Overflow	
U128	8-18-84	--	Liquid	Primary Clarifier Overflow	
U129	8-19-84	0832	Gas Canister	CAS Outlet	

Appendix I

Analytical Results for Liquid Samples

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-002
SAMPLE TYPE: LIQUID

DATE SAMPLED: 07/18/84
DATE ANALYZED: 08/13/84

COMPOUND	CONCENTRATION (NG-C/ML)	(MG/L)*
PARAFFINS		
C-2 VOC	258000	302
C-3 VOC	3220	3.77
ISOHEXANE	460	0.551
3-METHYLHEPTANE	365	0.434
2,2,5-TRIMETHYLHEXANE	449	0.6
C9 ALKANE	4670	5.55
C10+ ALKANE	1140	1.35
C10+ ALKANE	350	0.415
C10+ ALKANE	992	1.18
OLEFINS		
ISOBUTENE + 1-BUTENE	491	0.574
T-2-BUTENE	370	0.432
2,4,4-TRIME-2-PENTENE	641	0.749
C-2-OCTENE	260	0.304
TOTAL AROMATICS		
BENZENE	5180	5.62
TOLUENE	391000	429
O-XYLENE	45200	50
TOTAL HALOGENATED HC		
DICHLORODIFLUOROMETHANE	6	0.06
1,2-DICHLOROETHANE	3720	15.3
CARBON TETRACHLORIDE	<1	<.013
1,2-DICHLOROPROPANE	1.2	0.00377
TETRACHLOROETHYLENE	25.9	0.179
CHLOROBENZENE	529	0.827
O-DICHLOROBENZENE	4.1	0.00837
1,1-DICHLOROETHANE	54	0.223
UNIDENTIFIED HALOGENATED HC	65	0.204
UNIDENTIFIED HALOGENATED HC	4	0.0126

COMPOUND	CONCENTRATION (NG-C/ML)	(MG/L)*
TOTAL OXYGENATED HC(B)		
BUTANONE	2150	3.23
3-PENTANONE	20500	29.4
PARAFFINS	270000	316
OLEFINS	1760	2.06
TOTAL AROMATICS	441000	484
TOTAL HALOGENATED HC	4410	16.9
TOTAL OXYGENATED HC	22700	32.6(B)
TOTAL NMHC	717000	819

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER
SAMPLE CONTROL NO: U-339
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/15/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
C-3 VOC	67.7	0.0792			
ISOBUTANE	8150	9.86			
N-BUTANE	4940	4.89			
N-HEXANE	239	0.286			
METHYLCYCLOHEXANE	181	0.212			
C6 ALKANE	284	0.34			
C9 ALKANE	521	0.619			
C9 ALKANE	192	0.121			
TOTAL AROMATICS					
BENZENE	45500	49.4			
TOLUENE	3150	3.45			
C9 AROMATIC	108	0.12			
TOTAL HALOGENATED HC					
T-1,2-DICHLOROETHYLENE	30.8	0.124			
CHLOROFORM	172	1.71			
1,2-DICHLOROETHANE	10800	44.6			
CHLOROBENZENE	15600	24.4			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	616	0.736			
UNIDENTIFIED VOC	192	0.229			
PARAFFINS	13600	16.4			
TOTAL AROMATICS	48800	52.9			
TOTAL HALOGENATED HC	26600	70.8			
UNIDENTIFIED VOC	808	0.965(C)			
TOTAL NMHC	89800	141			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

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          FIELD ID NO:  PRIMARY CLARIFIER
          SAMPLE CONTROL NO:  U-010                                                          DATE SAMPLED:    08/15/84
          SAMPLE TYPE:   LIQUID                                                              DATE ANALYZED:   09/20/84
--------------------------------------------------------------------------------------------------------------------------

      COMPOUND                         CONCENTRATION                                                    CONCENTRATION
      --------                     (NG-C/ML)    (MG/L)*          COMPOUND                          (NG-C/ML)    (MG/L)*
                                   -------------------           --------                          -------------------
PARAFFINS
---------
 ISOBUTANE
 N-BUTANE                               1940       2.35
 N-HEXANE                               1220       1.48
 METHYLCYCLOHEXANE                       648       0.776
 C6 ALKANE                               132       0.154
 C10+ ALKANE                             176       0.211
 C10+ ALKANE                            76.5       0.0907
                                         163       0.193
TOTAL AROMATICS
---------------
 BENZENE
 TOLUENE                               46800      50.8
 ETHYLBENZENE                           4150       4.55
 P-XYLENE/M-XYLENE                       987       1.09
 STYRENE                               34300      37.9
 C10+ AROMATIC                          3910       4.24
                                        82.9       0.0927
TOTAL HALOGENATED HC
--------------------
 CHLOROFORM
 1,2-DICHLOROETHANE                      922       9.17
 1,2-DICHLOROPROPANE                   10300      42.5
 CHLOROBENZENE                          40.3       0.126
                                       16200      25.3
PARAFFINS
TOTAL AROMATICS                         4360       5.25
TOTAL HALOGENATED HC                   90200      98.7
                                       27500      77.1
TOTAL NMHC
                                      122000       181

--------------------------------------------------------------------------------------------------------------------------
(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

 *   UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-015
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/15/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
C-3 VOC	71.7	0.0838			
ISOBUTANE	6140	7.43			
N-BUTANE	4570	5.53			
NEOHEXANE	128	0.153			
N-HEXANE	1020	1.22			
N-HEPTANE	583	0.436			
C8 ALKANE	99	0.118			
TOTAL AROMATICS					
BENZENE	137000	149			
TOLUENE	8050	8.82			
ETHYLBENZENE	266	0.294			
STYRENE	160	0.173			
TOTAL HALOGENATED HC					
CHLOROMETHANE	22.2	0.0934			
METHYLENE CHLORIDE	9860	69.8			
CHLOROFORM	1790	17.8			
1,2-DICHLOROETHANE	20500	84.6			
1,1,1-TRICHLOROETHANE	460	2.56			
TETRACHLOROETHYLENE	6.2	0.0428			
CHLOROBENZENE	37000	57.9			
PARAFFINS	12600	15.2			
TOTAL AROMATICS	145000	158			
TOTAL HALOGENATED HC	69600	233			
TOTAL NMHC	228000	406			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-028A
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/20/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
ISOBUTANE	8290	10			
N-BUTANE	1870	2.26			
ISOPENTANE	894	1.08			
N-PENTANE	974	1.17			
NEOHEXANE	305	0.365			
CYCLOPENTANE	307	0.359			
2,3-DIMETHYLBUTANE	427	0.511			
3-METHYLPENTANE	133	0.159			
N-HEXANE	197	0.236			
C6 ALKANE	115	0.138			
C8 ALKANE	64.8	0.0771			
C10+ ALKANE	68.5	0.0812			
TOTAL AROMATICS					
BENZENE	19300	20.9			
TOLUENE	9050	9.92			
TOTAL HALOGENATED HC					
T-1,2-DICHLOROETHYLENE	4.92	0.0199			
CHLOROFORM	21.8	0.217			
1,2-DICHLOROETHANE	5640	23.3			
CHLOROBENZENE	991	1.55			
TOTAL OXYGENATED HC(B)					
METHANOL	1470	3.92			
PARAFFINS	13600	16.5			
TOTAL AROMATICS	28400	30.9			
TOTAL HALOGENATED HC	5660	25.1			
TOTAL OXYGENATED HC	1470	3.92(B)			
TOTAL NMHC	48700	72.4			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-0268
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION		COMPOUND	CONCENTRATION	
	(NG-C/ML)	(MG/L)*		(NG-C/ML)	(MG/L)*
PARAFFINS					
C-3 VOC	64.1	0.075			
N-BUTANE	5870	7.11			
NEOHEXANE	88.6	0.106			
N-HEXANE	128	0.153			
C6 ALKANE	277	0.332			
C8 ALKANE	112	0.133			
TOTAL AROMATICS					
BENZENE	24300	26.4			
TOLUENE	6990	7.66			
TOTAL HALOGENATED HC					
T-1,2-DICHLOROETHYLENE	5.04	0.0203			
CHLOROFORM	36.4	0.362			
1,2-DICHLOROETHANE	6830	28.2			
CHLOROBENZENE	1840	2.88			
UNIDENTIFIED HALOGENATED HC	61.3	0.192			
TOTAL OXYGENATED HC(B)					
ACETONE	681	1.1			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	905	1.08			
UNIDENTIFIED VOC	77.2	0.0922			
PARAFFINS	6540	7.9			
TOTAL AROMATICS	31300	34			
TOTAL HALOGENATED HC	8770	31.6			
TOTAL OXYGENATED HC	681	1.1(B)			
UNIDENTIFIED VOC	982	1.17(C)			
TOTAL NMHC	47600	74.7			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-328DA
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
C-3 VOC	56.6	0.0562			
N-BUTANE	2640	3.2			
N-HEXANE	146	0.175			
C6 ALKANE	95	0.114			
C8 ALKANE	115	0.137			
C9 ALKANE	161	0.191			
C10+ ALKANE	153	0.181			
OLEFINS					
3-HEPTENE	331	0.387			
TOTAL AROMATICS					
BENZENE	24400	26.5			
TOLUENE	4930	5.41			
TOTAL HALOGENATED HC					
CHLOROMETHANE	110	0.463			
CHLOROFORM	31.7	0.315			
1,2-DICHLOROETHANE	7130	29.4			
CHLOROBENZENE	1670	2.61			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	65.3	0.078			
PARAFFINS	3370	4.06			
OLEFINS	331	0.387			
TOTAL AROMATICS	29300	31.9			
TOTAL HALOGENATED HC	8940	32.8			
UNIDENTIFIED VOC	65.3	0.078(C)			
TOTAL NMHC	42000	69.2			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-32PDB
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION		COMPOUND	CONCENTRATION	
	(NG-C/ML)	(MG/L)*		(NG-C/ML)	(MG/L)*
PARAFFINS					
C-3 VOC	65.5	0.0766			
ISOBUTANE	15300	18.5			
NEOHEXANE	154	0.184			
N-HEXANE	178	0.213			
2,2,4-TRIMETHYLPENTANE	431	0.513			
C6 ALKANE	241	0.289			
C8 ALKANE	118	0.14			
C9 ALKANE	51.6	0.0613			
TOTAL AROMATICS					
BENZENE	22600	24.5			
TOLUENE	4260	4.67			
TOTAL HALOGENATED HC					
T-1,2-DICHLOROETHYLENE	53	0.214			
CHLOROFORM	31.1	0.379			
1,2-DICHLOROETHANE	6730	27.8			
TRICHLOROETHYLENE + BROMODICHLOROMETHANE	27.2	0.149			
CHLOROBENZENE	1610	2.52			
PARAFFINS	16500	20			
TOTAL AROMATICS	26900	29.2			
TOTAL HALOGENATED HC	8450	31			
TOTAL NMHC	51900	80.1			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-353
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/20/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
ISOBUTANE	23700	28.7			
N-HEXANE	316	0.378			
3-METHYLHEPTANE	155	0.184			
C6 ALKANE	240	0.287			
C6 ALKANE	1060	1.27			
C6 ALKANE	1160	1.39			
C8 ALKANE	89.4	0.106			
C8 ALKANE	95.5	0.114			
C9 ALKANE	171	0.203			
C10+ ALKANE	136	0.161			
C10+ ALKANE	220	0.261			
C10+ ALKANE	110	0.13			
C10+ ALKANE	302	0.358			
TOTAL AROMATICS					
BENZENE	125000	136			
TOLUENE	2850	3.12			
ETHYLBENZENE	869	0.961			
ISOBUTYLBENZENE	54.6	0.0611			
TOTAL HALOGENATED HC					
CHLOROFORM	374	3.72			
1,2-DICHLOROETHANE	13400	55.3			
1,1,1-TRICHLOROETHANE	132	0.734			
CHLOROBENZENE	1000	1.56			
TOTAL OXYGENATED HC(B)					
METHANOL	2000	5.33			
PARAFFINS	27800	33.5			
TOTAL AROMATICS	129000	140			
TOTAL HALOGENATED HC	14900	61.3			
TOTAL OXYGENATED HC	2000	5.33(B)			
TOTAL NMHC	171000	235			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-061
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/20/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS		
ISOBUTANE	8570	10.4
N-BUTANE	2260	2.74
N-HEXANE	99.6	0.119
ISOHEPTANE	42.6	0.0508
2,2,4-TRIMETHYLPENTANE	97.4	0.116
N-HEPTANE	58.2	0.0694
3-METHYLHEPTANE	231	0.275
C6 ALKANE	228	0.273
C7 ALKANE	80.2	0.0957
C8 ALKANE	450	0.535
C10+ ALKANE	146	0.173
C10+ ALKANE	330	0.391
OLEFINS		
4-METHYL-1-PENTENE	180	0.21
TOTAL AROMATICS		
BENZENE	14600	15.8
TOLUENE	7410	8.12
ETHYLBENZENE	23100	25.6
STYRENE	2520	2.73
ISOBUTYLBENZENE	523	0.585
TOTAL HALOGENATED HC		
CHLOROFORM	42.8	0.426
1,2-DICHLOROETHANE	17400	71.8
TRICHLOROETHYLENE + BROMODICHLOROMETHANE	6.88	0.0486
CHLOROBENZENE	5780	9.04
TOTAL OXYGENATED HC(B)		
METHANOL	1510	4.03
ACETONE	556	0.897

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	183	0.219
UNIDENTIFIED VOC	5400	6.45
PARAFFINS	12600	15.2
OLEFINS	180	0.21
TOTAL AROMATICS	48200	52.8
TOTAL HALOGENATED HC	23200	81.3
TOTAL OXYGENATED HC	2070	4.92(B)
UNIDENTIFIED VOC	5580	6.67(C)
TOTAL NMHC	89700	156

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER
SAMPLE CONTROL NO: U061T
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 10/03/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS		
N-HEXANE	172	0.206
CYCLOHEXANE	124	0.145
ISOHEPTANE	311	0.371
METHYLCYCLOHEXANE	482	0.563
C7 ALKANE	119	0.142
C7 ALKANE	600	0.716
C7 ALKANE	304	0.363
C8 ALKANE	52.1	0.062
C9 ALKANE	260	0.309
C9 ALKANE	277	0.329
C10+ ALKANE	774	0.918
C10+ ALKANE	545	0.646
C10+ ALKANE	94.6	0.112
C10+ ALKANE	1020	1.21
C10+ ALKANE	76.8	0.0911
OLEFINS		
C-3-METHYL-2-PENTENE	888	1.04
2,4,4-TRIME-2-PENTENE	412	0.482
1-NONENE	1650	1.93
B-PINENE	370	0.42
TOTAL AROMATICS		
BENZENE	13300	14.4
TOLUENE	7720	8.46
STYRENE	423	0.459
O-XYLENE	201	0.222
M-ETHYLTOLUENE	1500	1.67
1,2,4-TRIMETHYLBENZENE	301	0.335
TOTAL HALOGENATED HC		
METHYLENE CHLORIDE	366	2.59
CHLOROFORM	105	1.04
1,2-DICHLOROETHANE	13.6	0.0561
1,1,1-TRICHLOROETHANE	2680	14.9
CARBON TETRACHLORIDE	16.1	0.206

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
TOTAL HALOGENATED HC (CONT'D)		
1,2-DICHLOROPROPANE	27.3	0.0853
TRICHLOROETHYLENE + BROMODICHLOROMETHANE	39.2	0.215
1,1,2-TRICHLOROETHANE	11.8	0.0656
TETRACHLOROETHYLENE	1.4	0.00967
CHLOROBENZENE	6980	10.9
M-DICHLOROBENZENE	31	0.0633
O-DICHLOROBENZENE	8.17	0.0167
UNIDENTIFIED HALOGENATED HC	23.1	0.0725
UNIDENTIFIED HALOGENATED HC	10.9	0.0342
TOTAL OXYGENATED HC(B)		
ACETONE	33400	53.9
BUTANONE	20500	30.8
PARAFFINS	5210	6.18
OLEFINS	3320	3.87
TOTAL AROMATICS	23400	25.6
TOTAL HALOGENATED HC	10300	30.3
TOTAL OXYGENATED HC	53900	84.7(B)
TOTAL NMHC	42300	65.9

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: PRIMARY CLARIFIER OVERFLOW
SAMPLE CONTROL NO: U-095
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION		COMPOUND	CONCENTRATION	
	(NG-C/ML)	(MG/L)*		(NG-C/ML)	(MG/L)*
PARAFFINS					
ISOBUTANE	12600	15.3			
N-BUTANE	344	0.416			
N-HEXANE	1580	1.89			
2,2,4-TRIMETHYLPENTANE	354	0.421			
N-HEPTANE	145	0.173			
METHYLCYCLOHEXANE	636	0.744			
C6 ALKANE	294	0.352			
C7 ALKANE	159	0.19			
C7 ALKANE	143	0.171			
C7 ALKANE	119	0.142			
C7 ALKANE	123	0.147			
C7 ALKANE	179	0.214			
C9 ALKANE	72	0.0855			
C10+ ALKANE	198	0.235			
TOTAL AROMATICS					
BENZENE	81000	87.9			
TOLUENE	4910	5.38			
TOTAL HALOGENATED HC					
CHLOROMETHANE	44.3	0.186			
METHYLENE CHLORIDE	124	0.877			
CHLOROFORM	2680	26.7			
1,2-DICHLOROETHANE	14100	58.2			
TRICHLOROETHYLENE + BROMODICHLOROMETHANE	18.7	0.102			
CHLOROBENZENE	2680	4.19			
PARAFFINS	16900	20.4			
TOTAL AROMATICS	85900	93.2			
TOTAL HALOGENATED HC	19600	90.2			
TOTAL NMHC	123000	214			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

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          FIELD ID NO:  PRIMARY CLARIFIER OVERFLOW                                          DATE SAMPLED:   08/18/84
          SAMPLE CONTROL NO:  U-096                                                         DATE ANALYZED:  09/20/84
          SAMPLE TYPE:    LIQUID
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       COMPOUND                          CONCENTRATION                                          CONCENTRATION
       --------                      (NG-C/ML)    (MG/L)*            COMPOUND                  (NG-C/ML)   (MG/L)*
                                     --------------------            --------                  --------------------
PARAFFINS
---------
 ISOBUTANE                                                       TOTAL NMHC                     109000       162
 N-BUTANE                              4060       4.91
 N-HEXANE                              5170       6.26
 3-METHYLHEXANE                        86.6      0.104
 2,2,4-TRIMETHYLPENTANE                99.9      0.119
 N-HEPTANE                              165      0.196
 C6 ALKANE                              101       0.12
 C7 ALKANE                              145      0.174
 C8 ALKANE                             75.9     0.0905
 C9 ALKANE                              303       0.36
 C9 ALKANE                              153      0.182
 C10+ ALKANE                            105      0.125
 C10+ ALKANE                            136      0.161
                                        568      0.674
TOTAL AROMATICS
---------------
 BENZENE                              32200       34.9
 TOLUENE                              51600       56.6
 1,2,4-TRIMETHYLBENZENE                92.3      0.103

TOTAL HALOGENATED HC
--------------------
 VINYL CHLORIDE                        30.4     0.0792
 T-1,2-DICHLOROETHYLENE                 101      0.408
 CHLOROFORM                              48      0.478
 1,2-DICHLOROETHANE                   13100         54
 1,2-DICHLOROPROPANE                   19.6     0.0615
 TETRACHLOROETHYLENE                    4.2      0.029
 CHLOROBENZENE                         1000       1.56
 UNIDENTIFIED HALOGENATED HC           2.92    0.00917

UNIDENTIFIED VOC(C)
---------------
 UNIDENTIFIED VOC
                                        119      0.142
PARAFFINS                             11200       13.5
TOTAL AROMATICS                       83900       91.6
TOTAL HALOGENATED HC                  14300       56.7
UNIDENTIFIED VOC                        119   0.142(C)

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(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

  *  UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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     FIELD ID NO:  PRIMARY CLARIFIER OVERFLOW
     SAMPLE CONTROL NO:  U-128                                                     DATE SAMPLED:    08/18/84
     SAMPLE TYPE:    LIQUID                                                        DATE ANALYZED:   09/21/84
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         COMPOUND                              CONCENTRATION                                             CONCENTRATION
         --------                            (NG-C/ML)   (MG/L)*           COMPOUND                    (NG-C/ML)   (MG/L)*
                                             -------------------           --------                    -------------------
 PARAFFINS
 ---------
  C-3 VO                                       67.2    0.0786
  ISOBUTANE                                    7280      8.81
  N-BUTANE                                     3390       4.1
  N-HEXANE                                      142      0.17
  2,2,4-TRIMETHYLPENTANE                        138     0.164
  3-METHYLHEPTANE                              69.1    0.0822
  2,2,5-TRIMETHYLHEXANE                        75.8     0.101
  N-DECANE                                      181     0.215
  C6 ALKANE                                    1130      1.35
  C7 ALKANE                                     101      0.12
  C7 ALKANE                                     156     0.186
  C8 ALKANE                                     301     0.358
  C9 ALKANE                                     147     0.175

 TOTAL AROMATICS
 ---------------
  BENZENE                                     42100      45.7
  TOLUENE                                     37100      40.7

 TOTAL HALOGENATED HC
 --------------------
  T-1,2-DICHLOROETHYLENE                        2.6    0.0105
  CHLOROFORM                                     28     0.279
  1,2-DICHLOROETHANE                          10200      42.1
  1,1,1-TRICHLOROETHANE                         140     0.778
  CHLOROBENZENE                                 876      1.37
  UNIDENTIFIED HALOGENATED HC                  1.17   0.00367

 TOTAL OXYGENATED HC(B)
 ----------------------
  ACETONE                                       646      1.04

 PARAFFINS                                    13200      15.9
 TOTAL AROMATICS                              79200      86.3
 TOTAL HALOGENATED HC                         11200      44.5
 TOTAL OXYGENATED HC                            646   1.04(B)

 TOTAL NMHC                                  104000       147


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 (A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
 (B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
 (C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

  *  UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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FIELD ID NO: LAGOON RECYCLE FROM FILTER AND CENTRIFUGES
SAMPLE CONTROL NO: U-033
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION		COMPOUND	CONCENTRATION	
	(NG-C/ML)	(MG/L)*		(NG-C/ML)	(MG/L)*
PARAFFINS					
C-3 VOC	88.9	0.104			
ISOBUTANE	3890	4.71			
N-BUTANE	4960	6			
NEOHEXANE	107	0.128			
2,2,5-TRIMETHYLHEXANE	297	0.397			
C6 ALKANE	228	0.273			
OLEFINS					
4-METHYL-1-PENTENE	211	0.247			
TOTAL AROMATICS					
BENZENE	4040	4.38			
TOLUENE	822	0.901			
ETHYLBENZENE	375	0.415			
STYRENE	113	0.123			
TOTAL HALOGENATED HC					
CHLOROFORM	10.2	0.101			
1,2-DICHLOROETHANE	1050	4.33			
1,1,1-TRICHLOROETHANE	1.66	0.00923			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	1990	2.38			
UNIDENTIFIED VOC	1460	1.74			
UNIDENTIFIED VOC	800	0.358			
UNIDENTIFIED VOC	211	0.252			
PARAFFINS	9570	11.6			
OLEFINS	211	0.247			
TOTAL AROMATICS	5350	5.82			
TOTAL HALOGENATED HC	1062	4.44			
UNIDENTIFIED VOC	4460	5.33(C)			
TOTAL NMHC	20700	27.5			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: LAGOON FEED FROM FILTER AND CENTRIFUGES
SAMPLE CONTROL NO: P-063
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/13/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION		COMPOUND	CONCENTRATION	
	(NG-C/ML)	(MG/L)*		(NG-C/ML)	(MG/L)*
PARAFFINS					
C-3 VOC	89	0.104			
ISOBUTANE	12100	14.6			
N-BUTANE	4820	5.83			
NEOHEXANE	113	0.135			
N-HEXANE	87.6	0.105			
3-METHYLHEPTANE	202	0.24			
C6 ALKANE	191	0.229			
C8 ALKANE	189	0.225			
C10+ ALKANE	56.9	0.0675			
C16+ ALKANE	373	0.442			
TOTAL AROMATICS					
BENZENE	3300	3.58			
TOLUENE	1130	1.24			
STYRENE	109	0.118			
TOTAL HALOGENATED HC					
CHLOROFORM	16.4	0.163			
1,2-DICHLOROETHANE	1150	4.74			
TETRACHLOROETHYLENE	3.1	0.0214			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	908	1.08			
UNIDENTIFIED VOC	259	0.309			
PARAFFINS	18200	22			
TOTAL AROMATICS	4540	4.94			
TOTAL HALOGENATED HC	1170	4.93			
UNIDENTIFIED VOC	1170	1.39(C)			
TOTAL NMHC	25100	33.3			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: LAGOON FEED FROM FILTER AND CENTRIFUGES
SAMPLE CONTROL NO: U-197
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/18/84
DATE ANALYZED: 09/20/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS		
C-3 VOC	80.4	0.094
ISOBUTANE	9770	11.8
N-BUTANE	876	1.06
ISOPENTANE	118	0.142
N-PENTANE	47.4	0.057
N-HEXANE	253	0.303
N-HEPTANE	98.2	0.117
METHYLCYCLOHEXANE	913	1.07
C6 ALKANE	73	0.0874
C7 ALKANE	112	0.134
C7 ALKANE	72	0.0859
C7 ALKANE	47.4	0.0565
C7 ALKANE	48.2	0.0575
C7 ALKANE	93.2	0.111
C9 ALKANE	44.6	0.053
C9 ALKANE	52.1	0.0619
C10+ ALKANE	113	0.13
TOTAL AROMATICS		
BENZENE	10100	11
TOLUENE	14200	15.6
ETHYLBENZENE	75.1	0.0831
P-XYLENE/M-XYLENE	83.3	0.0922
ISOBUTYLBENZENE	352	0.394
TOTAL HALOGENATED HC		
T-1,2-DICHLOROETHYLENE	34.8	0.141
CHLOROFORM	31.6	0.314
1,2-DICHLOROETHANE	1230	5.07
1,1,1-TRICHLOROETHANE	18.8	0.104
TOTAL OXYGENATED HC(B)		
METHANOL	1570	4.19

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	344	0.411
PARAFFINS	12800	15.4
TOTAL AROMATICS	24800	27.1
TOTAL HALOGENATED HC	1320	5.63
TOTAL OXYGENATED HC	1570	4.19(B)
UNIDENTIFIED VOC	344	0.411(C)
TOTAL NMHC	39308	48.6

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: SECONDARY CLARIFIER FEED
SAMPLE CONTROL NO: U-031
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/20/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
ISOBUTANE	2550	3.09	TOTAL NMHC	40500	49.4
N-BUTANE	1200	1.45			
ISOPENTANE	578	0.696			
N-PENTANE	395	0.475			
NEOHEXANE	610	0.73			
CYCLOPENTANE	220	0.257			
2,3-DIMETHYLBUTANE	132	0.158			
N-HEXANE	175	0.21			
C9 ALKANE	187	0.222			
C10+ ALKANE	103	0.122			
TOTAL AROMATICS					
BENZENE	272	0.295			
TOLUENE	775	0.85			
ETHYLBENZENE	4910	5.43			
P-XYLENE/M-XYLENE	21100	23.3			
STYRENE	2790	3.03			
TOTAL HALOGENATED HC					
CHLOROFORM	18	0.179			
1,2-DICHLOROETHANE	1080	4.46			
1,1,1-TRICHLOROETHANE	65.8	0.366			
TOTAL OXYGENATED HC(B)					
METHANOL	1240	3.31			
ETHANOL	466	0.993			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	3370	4.03			
PARAFFINS	6150	7.41			
TOTAL AROMATICS	29800	32.9			
TOTAL HALOGENATED HC	1160	5			
TOTAL OXYGENATED HC	1710	4.2(B)			
UNIDENTIFIED VOC	3370	4.03(C)			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: SECONDARY CLARIFIER FEED
SAMPLE CONTROL NO: U-95*
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 09/20/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS		
ISOBUTANE	16500	20
N-BUTANE	2250	2.72
C6 ALKANE	135	0.162
C6 ALKANE	303	0.363
C8 ALKANE	89.9	0.107
C8 ALKANE	265	0.315
C9 ALKANE	141	0.168
C10+ ALKANE	209	0.248
C10+ ALKANE	171	0.203
C10+ ALKANE	147	0.174
C10+ ALKANE	679	0.805
TOTAL AROMATICS		
BENZENE	1679	1.81
TOLUENE	251	0.275
ETHYLBENZENE	753	0.833
TOTAL HALOGENATED HC		
T-1,2-DICHLOROETHYLENE	58.7	0.237
CHLOROFORM	38.2	0.38
1,1,1-TRICHLOROETHANE	235	1.31
CARBON TETRACHLORIDE	40.5	0.519
TOTAL OXYGENATED HC(B)		
ACETONE	1990	3.21
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	1670	1.99
UNIDENTIFIED VOC	6229	7.43
UNIDENTIFIED VOC	983	1.17
PARAFFINS	20900	25.2
TOTAL AROMATICS	2670	2.92
TOTAL HALOGENATED HC	372	2.44
TOTAL OXYGENATED HC	1990	3.21(B)

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
UNIDENTIFIED VOC	8870	10.6(C)
TOTAL NMHC	32800	41.2

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: SECONDARY CLARIFIER FEED
SAMPLE CONTROL NO: U-048
SAMPLE TYPE: LIQUID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/21/84

COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*	COMPOUND	CONCENTRATION (NG-C/ML)	CONCENTRATION (MG/L)*
PARAFFINS					
C-3 VOC	68.1	0.0796			
ISOBUTANE	9050	11			
N-BUTANE	4830	5.85			
NEOHEXANE	116	0.139			
N-HEXANE	89.5	0.107			
C8 ALKANE	64.4	0.0766			
C9 ALKANE	136	0.162			
C9 ALKANE	85.6	0.102			
TOTAL AROMATICS					
ETHYLBENZENE	312	0.345			
TOTAL HALOGENATED HC					
CHLOROFORM	8.55	0.0851			
1,2-DICHLOROETHANE	1500	6.19			
TETRACHLOROETHYLENE	8.61	0.0595			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	857	1.02			
PARAFFINS	14400	17.5			
TOTAL AROMATICS	312	0.345			
TOTAL HALOGENATED HC	1520	6.33			
UNIDENTIFIED VOC	857	1.02(C)			
TOTAL NMHC	17100	25.2			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

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        FIELD ID NO:  SECONDARY CLARIFIER FEED
        SAMPLE CONTROL NO:  U-09P                                             DATE SAMPLED:    08/18/84
        SAMPLE TYPE:    LIQUID                                                DATE ANALYZED:   09/20/84
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      COMPOUND                       CONCENTRATION                                        CONCENTRATION
      --------                  (NG-C/ML)    (MG/L)*         COMPOUND                (NG-C/ML)    (MG/L)*
                                -------------------          --------                -------------------
 PARAFFINS
 ---------
  C-3 VOC
  ISOBUTANE                         64.2    0.0751
  N-BUTANE                         15400      18.6
  ISOPENTANE                         333     0.403
  N-PENTANE                          291      0.35
  N-HEXANE                           540      0.65
  C6 ALKANE                         59.6    0.0714
  C10+ ALKANE                        121     0.145
  C10+ ALKANE                        237     0.281
  C10+ ALKANE                        112     0.133
                                     222     0.263
 TOTAL AROMATICS
 ---------------
  BENZENE
  ETHYLBENZENE                       261     0.283
  ISOBUTYLBENZENE                   1480      1.64
                                     492      0.55
 TOTAL HALOGENATED HC
 --------------------
  CHLOROFORM
  1,2-DICHLOROETHANE                17.1      0.17
  1,1,1-TRICHLOROETHANE             1490      6.15
  UNIDENTIFIED HALOGENATED HC       20.2     0.112
                                     120     0.377
 PARAFFINS
 TOTAL AROMATICS                   17400        21
 TOTAL HALOGENATED HC               2230      2.47
                                    1650      6.81
 TOTAL NMHC
                                   21300      30.3

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(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

  *  UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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Appendix J
Analytical Results for Sludge Samples

FIELD ID NO: CENTRIFUGE #1 SLUDGE
SAMPLE CONTROL NO: U034
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/04/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
3-METHYLHEPTANE	2190	2.61
2,2,5-TRIMETHYLHEXANE	6430	8.59
N-NONANE	5380	6.39
N-DECANE	6030	7.15
N-UNDECANE	14900	17.5
C5 ALKANE	4240	5.08
C9 ALKANE	6910	8.21
C9 ALKANE	1230	1.46
C9 ALKANE	3110	3.69
C10+ ALKANE	13800	16.4
C10+ ALKANE	18400	21.8
C10+ ALKANE	8950	10.6
C10+ ALKANE	10200	12.1
C10+ ALKANE	19200	22.8
C10+ ALKANE	15100	17.9
C10+ ALKANE	1760	2.09
C10+ ALKANE	635	0.753
OLEFINS		
1-NONENE	11800	13.8
A-PINENE	8130	9.23
B-PINENE	13100	14.9
1-UNDECENE	18900	22.1
TOTAL AROMATICS		
P-XYLENE/M-XYLENE	4330	4.79
STYRENE	17000	18.4
ISOPROPYLBENZENE	5330	5.93
M-ETHYLTOLUENE	14500	16.1
P-ETHYLTOLUENE	29200	32.5
1,2,4-TRIMETHYLBENZENE	6290	7
INDAN	17900	19.6
N-BUTYLBENZENE	12500	14
NAPHTHALENE	6430	6.87
C10+ AROMATIC	49300	55.1

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
TOTAL HALOGENATED HC		
1,2-DICHLOROETHANE	174	0.718
1,1,1-TRICHLOROETHANE	315	1.75
P-DICHLOROBENZENE	87.7	0.179
UNIDENTIFIED HALOGENATED HC	99	0.311
TOTAL OXYGENATED HC(B)		
HEXANAL	6080	8.46
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	3740	4.47
UNIDENTIFIED VOC	12700	15.2
UNIDENTIFIED VOC	5760	6.88
UNIDENTIFIED VOC	8820	10.5
UNIDENTIFIED VOC	6320	7.55
UNIDENTIFIED VOC	8930	10.7
PARAFFINS	138000	165
OLEFINS	51900	60
TOTAL AROMATICS	163000	180
TOTAL HALOGENATED HC	676	2.96
TOTAL OXYGENATED HC	6080	8.46(B)
UNIDENTIFIED VOC	46300	55.3(C)
TOTAL NMHC	400000	464

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CENTRIFUGE #1 SLUDGE
SAMPLE CONTROL NO: U034D
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/04/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
ISOPENTANE	4750	5.72
2,4-DIMETHYLPENTANE	7460	8.9
METHYLCYCLOHEXANE	593	0.693
N-DECANE	3180	3.78
N-UNDECANE	1710	2.02
C6 ALKANE	2650	3.17
C7 ALKANE	696	0.83
C7 ALKANE	640	0.763
C7 ALKANE	1150	1.37
C9 ALKANE	2940	3.49
C9 ALKANE	1450	1.72
C9 ALKANE	6050	7.19
C9 ALKANE	4280	5.08
C10+ ALKANE	2030	2.41
C10+ ALKANE	2960	3.51
C10+ ALKANE	6180	7.33
C10+ ALKANE	5550	6.58
C10+ ALKANE	10900	12.9
C10+ ALKANE	3160	3.75
C10+ ALKANE	14900	17.7
C10+ ALKANE	10100	12
C10+ ALKANE	13900	16.5
C10+ ALKANE	7980	9.34
C10+ ALKANE	1920	2.28
C10+ ALKANE	10100	12
OLEFINS		
ISOBUTENE + 1-BUTENE	560	0.665
A-PINENE	2190	2.49
1-UNDECENE	5960	6.97
C10+ ALKENE	24600	28.8
TOTAL AROMATICS		
STYRENE	1380	1.5
N-PROPYLBENZENE	6340	7.06
P-ETHYLTOLUENE	2010	2.24
C10+ AROMATIC	2570	2.87
TOTAL AROMATICS (CONT'D)		
C10+ AROMATIC	7490	8.38
C10+ AROMATIC	4690	5.24
C10+ AROMATIC	14100	15.8
C10+ AROMATIC	6550	7.33
TOTAL HALOGENATED HC		
CHLOROFORM	30.7	0.305
1,2-DICHLOROETHANE	1390	5.73
CARBON TETRACHLORIDE	119	1.53
CHLOROBENZENE	2360	3.69
M-DICHLOROBENZENE	98.5	0.201
P-DICHLOROBENZENE	507	1.04
UNIDENTIFIED HALOGENATED HC	484	1.52
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	1500	1.79
UNIDENTIFIED VOC	2560	3.06
UNIDENTIFIED VOC	2850	3.4
UNIDENTIFIED VOC	1520	1.82
PARAFFINS	127000	151
OLEFINS	33300	38.9
TOTAL AROMATICS	45100	50.4
TOTAL HALOGENATED HC	4990	14
UNIDENTIFIED VOC	8430	10.1(C)
TOTAL NMHC	219000	264

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CENTRIFUGE #1 SLUDGE
SAMPLE CONTROL NO: U121
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/18/84
DATE ANALYZED: 10/11/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
ISOHEPTANE	4950	5.9
N-HEPTANE	4540	5.42
METHYLCYCLOHEXANE	4200	4.91
N-OCTANE	4800	5.71
N-NONANE	2910	3.46
N-UNDECANE	2420	2.87
C7 ALKANE	3900	4.64
C7 ALKANE	4510	5.38
C7 ALKANE	10200	12.2
C9 ALKANE	1980	2.23
C9 ALKANE	8310	9.87
C9 ALKANE	6670	7.92
C10+ ALKANE	743	0.881
C10+ ALKANE	768	0.934
C10+ ALKANE	812	0.963
C10+ ALKANE	997	1.18
C10+ ALKANE	1760	2.09
C10+ ALKANE	1330	1.58
C10+ ALKANE	1500	1.78
C10+ ALKANE	3250	3.85
TOTAL AROMATICS		
BENZENE	4370	4.74
1,2,4-TRIMETHYLBENZENE	4200	4.67
C10+ AROMATIC	713	0.797
C10+ AROMATIC	2810	3.13
TOTAL HALOGENATED HC		
CHLOROFORM	111	1.1
1,2-DICHLOROETHANE	1810	7.47
CARBON TETRACHLORIDE	82.3	1.05
CHLOROBENZENE	3490	5.46
M-DICHLOROBENZENE	184	0.376
P-DICHLOROBENZENE	684	1.4
UNIDENTIFIED HALOGENATED HC	162	0.509
UNIDENTIFIED HALOGENATED HC	3230	10.1
UNIDENTIFIED HALOGENATED HC	1290	4.05

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
TOTAL HALOGENATED HC (CONT'D)		
UNIDENTIFIED HALOGENATED HC	804	2.52
TOTAL OXYGENATED HC(B)		
ETHANOL	5360	10.3
1-BUTANOL	10500	16.2
PARAFFINS	70500	83.7
TOTAL AROMATICS	12100	13.3
TOTAL HALOGENATED HC	11800	34.1
TOTAL OXYGENATED HC	15900	26.5(B)
TOTAL NMHC	94400	131

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CENTRIFUGE #2 SLUDGE
SAMPLE CONTROL NO: U035A
SAMPLE TYPE: SOLID

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/10/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
N-HEPTANE	826	0.985
METHYLCYCLOHEXANE	535	0.625
N-NONANE	776	0.922
C6 ALKANE	1720	2.06
C9 ALKANE	1960	2.33
C9 ALKANE	6680	7.94
C9 ALKANE	4780	5.68
C9 ALKANE	3730	4.4
C9 ALKANE	2880	3.42
C9 ALKANE	2380	2.83
C9 ALKANE	1310	1.56
C10+ ALKANE	2020	2.4
C10+ ALKANE	881	1.04
C10+ ALKANE	1540	1.83
C10+ ALKANE	1910	2.26
C10+ ALKANE	1060	1.26
OLEFINS		
ISOBUTENE + 1-BUTENE	1230	1.44
C-3-METHYL-2-PENTENE	7960	9.31
TOTAL AROMATICS		
C10+ AROMATIC	44600	49.9
TOTAL HALOGENATED HC		
T-1,2-DICHLOROETHYLENE	53.8	0.217
CHLOROFORM	86.3	0.859
1,2-DICHLOROETHANE	638	2.63
P-DICHLOROBENZENE	240	0.508
UNIDENTIFIED HALOGENATED HC	221	0.694
UNIDENTIFIED HALOGENATED HC	552	1.73
UNIDENTIFIED HALOGENATED HC	1010	3.17

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
TOTAL OXYGENATED HC(B)		
2-PROPANOL	5310	8.86
1-BUTANOL	15800	24.4
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	9330	11.1
PARAFFINS	35000	41.5
OLEFINS	9190	10.7
TOTAL AROMATICS	44600	49.9
TOTAL HALOGENATED HC	2810	9.81
TOTAL OXYGENATED HC	21100	33.3(B)
UNIDENTIFIED VOC	9330	11.1(C)
TOTAL NMHC	101000	123

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CENTRIFUGE #2 SLUDGE
SAMPLE CONTROL NO: U-0356
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/10/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
N-HEPTANE	1100	1.31
METHYLCYCLOHEXANE	694	0.811
N-NONANE	3260	3.87
N-DECANE	2010	2.38
C6 ALKANE	4960	5.94
C6 ALKANE	6260	7.49
C9 ALKANE	764	0.908
C9 ALKANE	635	0.754
C10+ ALKANE	3130	3.71
C10+ ALKANE	4290	5.09
C10+ ALKANE	2240	2.66
C10+ ALKANE	1790	2.12
OLEFINS		
ISOBUTENE + 1-BUTENE	1610	1.88
C-3-METHYL-2-PENTENE	9530	11.1
TOTAL AROMATICS		
BENZENE	1680	1.82
C10+ AROMATIC	52000	58.2
C10+ AROMATIC	27600	30.9
TOTAL HALOGENATED HC		
CHLOROFORM	122	1.21
1,2-DICHLOROETHANE	685	2.83
P-DICHLOROBENZENE	402	0.821
UNIDENTIFIED HALOGENATED HC	212	0.665
UNIDENTIFIED HALOGENATED HC	245	0.769
UNIDENTIFIED HALOGENATED HC	144	0.452
TOTAL OXYGENATED HC(B)		
2-PROPANOL	24000	40.1

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	1950	2.33
UNIDENTIFIED VOC	1100	1.31
PARAFFINS	31100	37.1
OLEFINS	11100	13
TOTAL AROMATICS	81300	90.8
TOTAL HALOGENATED HC	1810	6.75
TOTAL OXYGENATED HC	24000	40.1(B)
UNIDENTIFIED VOC	3050	3.64(C)
TOTAL NMHC	128000	151

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CENTRIFUGE #2 SLUDGE
SAMPLE CONTROL NO: U122
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/18/84
DATE ANALYZED: 10/11/84

COMPOUND	CONCENTRATION (NG-C/G)	(UG/G)*	COMPOUND	CONCENTRATION (NG-C/G)	(UG/G)*
PARAFFINS					
ISOHEPTANE	1350	1.61			
N-HEPTANE	1240	1.48			
METHYLCYCLOHEXANE	893	1.04			
N-UNDECANE	2910	3.45			
C7 ALKANE	489	0.583			
C8 ALKANE	1180	1.4			
C9 ALKANE	664	0.789			
C9 ALKANE	818	0.972			
C9 ALKANE	374	0.444			
C10+ ALKANE	2640	3.13			
TOTAL AROMATICS					
BENZENE	2190	2.38			
1,2,4-TRIMETHYLBENZENE	907	1.01			
TOTAL HALOGENATED HC					
CHLOROFORM	120	1.19			
1,2-DICHLOROETHANE	1980	4.46			
1,1,1-TRICHLOROETHANE	73.3	0.407			
CARBON TETRACHLORIDE	75.1	0.963			
C-1,3-DICHLOROPROPENE	207	0.638			
CHLOROBENZENE	1970	3.08			
M-DICHLOROBENZENE	91.3	0.186			
P-DICHLOROBENZENE	281	0.573			
UNIDENTIFIED HALOGENATED HC	379	1.19			
TOTAL OXYGENATED HC(B)					
ETHANOL	735	1.41			
1-BUTANOL	2660	4.11			
PARAFFINS	12600	14.9			
TOTAL AROMATICS	3100	3.38			
TOTAL HALOGENATED HC	4280	12.7			
TOTAL OXYGENATED HC	3400	5.52(B)			
TOTAL NMHC	19900	31			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: FILTER BELT SLUDGE
SAMPLE CONTROL NO: U036
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/10/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
CYCLOHEXANE	463	0.541
N-HEPTANE	15200	18.1
METHYLCYCLOHEXANE	18700	21.9
N-DECANE	1330	1.58
N-UNDECANE	1430	1.69
C6 ALKANE	19900	23.8
C7 ALKANE	5750	6.86
C7 ALKANE	4710	5.62
C7 ALKANE	8220	9.81
C9 ALKANE	3920	4.66
C9 ALKANE	1950	1.25
C9 ALKANE	2120	2.52
C9 ALKANE	954	1.13
C10+ ALKANE	974	1.16
C10+ ALKANE	2080	2.47
C10+ ALKANE	2990	3.55
C10+ ALKANE	762	0.904
C10+ ALKANE	1430	1.66
C10+ ALKANE	941	1.12
C10+ ALKANE	1180	1.4
C10+ ALKANE	1800	2.13
C10+ ALKANE	1960	2.35
C10+ ALKANE	555	0.658
C10+ ALKANE	1060	1.26
OLEFINS		
CYCLOHEXENE	43300	49.9
LIMONENE	1730	1.96
1-UNDECENE	2280	2.67
TOTAL AROMATICS		
BENZENE	109000	118
TOLUENE	45100	49.4
STYRENE	2120	2.3
N-PROPYLBENZENE	1310	1.46
P-ETHYLTOLUENE	2150	2.39
1,3,5-TRIMETHYLBENZENE	1650	1.84
TOTAL AROMATICS (CONT'D)		
1,2,4-TRIMETHYLBENZENE	4640	5.16
INDAN	884	0.967
INDENE	1510	1.62
C10+ AROMATIC	2130	2.38
C10+ AROMATIC	6080	6.8
C10+ AROMATIC	222000	248
TOTAL HALOGENATED HC		
METHYLENE CHLORIDE	244	1.73
T-1,2-DICHLOROETHYLENE	40.6	0.164
CHLOROFORM	287	2.86
1,2-DICHLOROETHANE	14500	59.8
CHLOROBENZENE	113000	177
M-DICHLOROBENZENE	526	1.07
P-DICHLOROBENZENE	1810	3.7
UNIDENTIFIED HALOGENATED HC	249	0.782
UNIDENTIFIED HALOGENATED HC	4310	13.5
UNIDENTIFIED HALOGENATED HC	141	0.443
TOTAL OXYGENATED HC(B)		
2-PROPANOL	17500	29.2
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	43000	51.4
UNIDENTIFIED VOC	1020	1.22
PARAFFINS	99500	118
OLEFINS	47300	54.5
TOTAL AROMATICS	399000	441
TOTAL HALOGENATED HC	135000	261
TOTAL OXYGENATED HC	17500	29.2(B)
UNIDENTIFIED VOC	44000	52.6(C)
TOTAL NMHC	724000	927

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: FILTER BELT SLUDGE
SAMPLE CONTROL NO: U034C
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/10/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
ISOHEPTANE	7670	9.15
N-HEPTANE	3350	4
METHYLCYCLOHEXANE	3180	3.72
N-NONANE	558	0.663
N-UNDECANE	1920	2.29
C6 ALKANE	3010	3.6
C7 ALKANE	3030	3.61
C7 ALKANE	2440	2.91
C7 ALKANE	4280	5.11
C8 ALKANE	929	1.11
C9 ALKANE	1050	1.25
C9 ALKANE	784	0.931
C9 ALKANE	1350	1.6
C9 ALKANE	1480	1.76
C10+ ALKANE	1400	1.66
C10+ ALKANE	1510	1.79
C10+ ALKANE	2200	2.61
C10+ ALKANE	1390	1.65
C10+ ALKANE	949	1.13
C10+ ALKANE	1370	1.62
C10+ ALKANE	1370	1.62
C10+ ALKANE	2110	2.5
C10+ ALKANE	3540	4.2
C10+ ALKANE	3870	4.59
C10+ ALKANE	849	1.01
C10+ ALKANE	2260	2.68
C10+ ALKANE	1260	1.49
C10+ ALKANE	1130	1.34
C10+ ALKANE	851	1.01
C10+ ALKANE	1410	1.67
C10+ ALKANE	1830	2.17
OLEFINS		
ISOBUTENE + 1-BUTENE	905	1.06
C-3-METHYL-2-PENTENE	4600	5.38
LIMONENE	2180	2.47
1-UNDECENE	1180	1.38
C10+ ALKENE	2620	3.06
OLEFINS (CONT'D)		
C10+ ALKENE	2040	2.39
C10+ ALKENE	3370	3.94
TOTAL AROMATICS		
BENZENE	1760	1.91
O-XYLENE	1790	1.98
M-ETHYLTOLUENE	1580	1.76
P-ETHYLTOLUENE	1780	1.98
O-ETHYLTOLUENE	854	0.95
1,2,4-TRIMETHYLBENZENE	3710	4.13
INDENE	685	0.737
P-DIETHYLBENZENE	2080	2.33
C10+ AROMATIC	6960	7.78
C10+ AROMATIC	30200	33.8
TOTAL HALOGENATED HC		
CHLOROFORM	44.1	0.439
1,2-DICHLOROETHANE	10400	42.9
BICHLOROMETHYL ETHER	139	0.666
C-1,3-DICHLOROPROPENE	181	0.558
CHLOROBENZENE	38000	59.4
M-DICHLOROBENZENE	515	1.05
P-DICHLOROBENZENE	1820	3.72
UNIDENTIFIED HALOGENATED HC	4740	14.9
UNIDENTIFIED HALOGENATED HC	446	1.4
UNIDENTIFIED HALOGENATED HC	181	0.568
TOTAL OXYGENATED HC(B)		
ISOBUTYRALDEHYDE	1060	1.59
VALERALDEHYDE	10500	15.1
PARAFFINS	64300	76.4
OLEFINS	16900	19.7
TOTAL AROMATICS	51400	57.3
TOTAL HALOGENATED HC	56500	126
TOTAL OXYGENATED HC	11600	16.7(B)

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: FILTER BELT SLUDGE
SAMPLE CONTROL NO: U036D
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/16/84
DATE ANALYZED: 10/10/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*	COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
TOTAL NMHC	189000	279			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: FILTER BELT SLUDGE
SAMPLE CONTROL NO: U123
SAMPLE TYPE: SLUDGE

DATE SAMPLED: 08/18/84
DATE ANALYZED: 10/11/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
CYCLOHEXANE	14800	17.3
ISOHEPTANE	167000	199
3-METHYLHEXANE	161000	192
N-HEPTANE	248000	296
METHYLCYCLOHEXANE	307000	358
2,5-DIMETHYLHEXANE	1120	1.33
N-OCTANE	1540	1.83
N-UNDECANE	5410	6.41
C7 ALKANE	53600	63.9
C7 ALKANE	125000	149
C8 ALKANE	17500	20.8
C9 ALKANE	1590	1.89
C10+ ALKANE	1280	1.52
C10+ ALKANE	2410	2.86
C10+ ALKANE	2630	3.12
C10+ ALKANE	1370	1.62
C10+ ALKANE	1390	1.65
C10+ ALKANE	2660	3.15
C10+ ALKANE	2780	3.3
C10+ ALKANE	4440	5.27
C10+ ALKANE	4420	5.24
C10+ ALKANE	5160	6.12
C10+ ALKANE	4170	4.94
C10+ ALKANE	2640	3.13
C10+ ALKANE	6690	7.93
C10+ ALKANE	965	1.14
C10+ ALKANE	1750	2.08
C10+ ALKANE	1180	1.4
C10+ ALKANE	1820	2.16
C10+ ALKANE	22300	26.4
OLEFINS		
1-PENTENE	5380	6.29
2,4,4-TRIME-2-PENTENE	5630	6.58
LIMONENE	3390	3.75
1-UNDECENE	3340	3.9
C6 ALKENE	3540	4.14
C10+ ALKENE	4530	5.3

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
OLEFINS (CONT'D)		
C10+ ALKENE	9490	11.1
TOTAL AROMATICS		
BENZENE	186000	202
TOLUENE	279000	306
P-XYLENE/M-XYLENE	1680	1.86
M-ETHYLTOLUENE	1550	1.73
P-ETHYLTOLUENE	1360	1.51
1,2,4-TRIMETHYLBENZENE	7360	8.19
INDENE	3060	3.29
C10+ AROMATIC	25200	28.2
TOTAL HALOGENATED HC		
CHLOROFORM	502	4.99
1,2-DICHLOROETHANE	15200	62.7
CARBON TETRACHLORIDE	407	5.22
CHLOROBENZENE	95500	149
BICHLOROETHYL ETHER	651	1.94
M-DICHLOROBENZENE	3140	6.41
P-DICHLOROBENZENE	2780	5.68
O-DICHLOROBENZENE	4560	9.31
UNIDENTIFIED HALOGENATED HC	225	0.706
UNIDENTIFIED HALOGENATED HC	9950	31.2
UNIDENTIFIED HALOGENATED HC	123	0.386
UNIDENTIFIED HALOGENATED HC	358	1.12
TOTAL OXYGENATED HC(B)		
ETHANOL	2600	4.98
ISOBUTYRALDEHYDE	2170	3.26
BUTYRALDEHYDE	1720	2.58
VALERALDEHYDE	53000	76.1
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	43700	52.2

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: FILTER BELT SLUDGE
SAMPLE CONTROL NO: U123
SAMPLE TYPE: SLUDGE

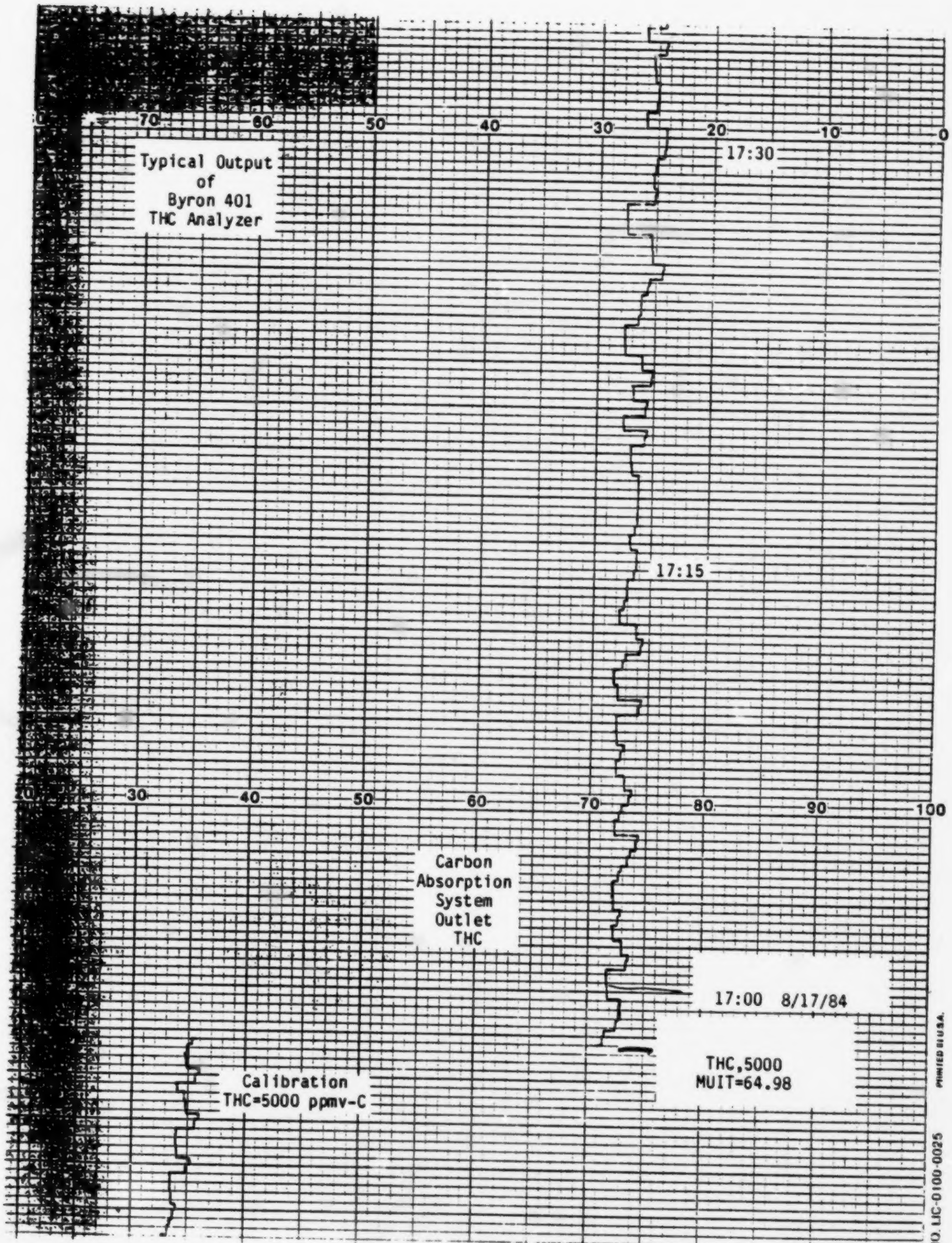
DATE SAMPLED: 08/18/84
DATE ANALYZED: 10/11/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*	COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS	1170000	1399			
OLEFINS	35200	41			
TOTAL AROMATICS	505000	552			
TOTAL HALOGENATED HC	133000	279			
TOTAL OXYGENATED HC	59500	86.9(B)			
UNIDENTIFIED VOC	43700	52.2(C)			
TOTAL NMHC	1890000	2320			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

Appendix K
Examples of On-Site Gas Analyzer Print-Outs



Typical Output
of
Byron 401
THC Analyzer

17:30

17:15

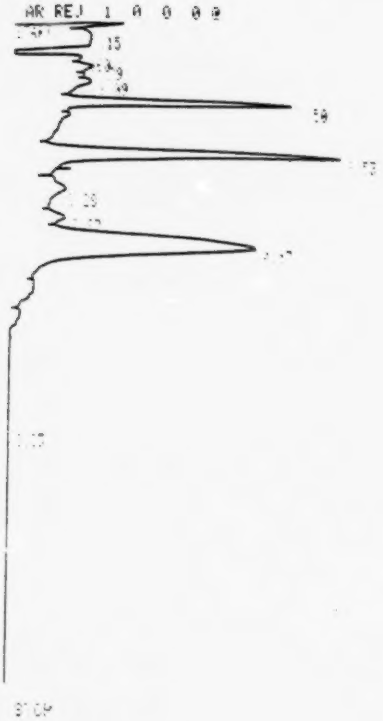
Carbon
Absorption
System
Outlet
THC

17:00 8/17/84

THC,5000
MUIT=64.98

Calibration
THC=5000 ppmv-C

Typical Output
of
HNU Systems Portable
Gas Chromatograph

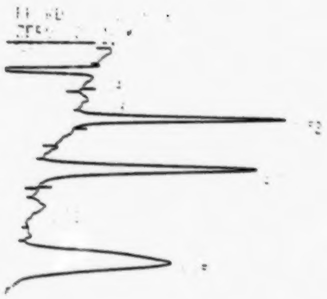


```
STOP

RUN #   22                JUL/31/84  21:56:20

AREA%
  RT             AREA TYPE   AR HT      AREA%
 0.15           62672   BP   0.576     11.163
 0.60           48316   PV   0.173      8.606
 0.79           61494   VV   0.223     10.954
 1.09           77166   VV   0.221     13.745
 [illegible]70  83075   VV   0.177     14.798
 [illegible]    79998   VD   0.198     14.250
                 7609   BV   0.706      1.355
 [illegible]     7666   VV   0.934      1.366
 4.43          129260   VV   0.426     23.024
 8.25            4153   PP   0.407      0.740

TOTAL AREA=     561410
MUL FACTOR= 1.0000E+00
```



```
STOP

RUN #   21                JUL/31/84  21:42:56

AREA%
  RT             AREA TYPE   AR HT      AREA%
 0.64           37496   PB   0.214     17.800
 1.52           33318   VB   0.115     15.817
 2.54           50826   PB   0.173     24.128
 4.45           89012 I VP   0.413     42.255

TOTAL AREA=     210650
MUL FACTOR= 1.0000E+00
```

Appendix L
Analytical Results of Gas-Phase NMHC Speciation For Carbon Adsorption System

FIELD ID NO: CARBON ADSORBER INLET
SAMPLE CONTROL NO: U-004
SAMPLE TYPE: CANISTER

DATE SAMPLED: 07/17/84
DATE ANALYZED: 07/20/84

COMPOUND	CONCENTRATION	
	(PPMV)	(UG/M**3)
PARAFFINS		
C-3 VOC	0.683	1180
ISOHEXANE	0.478	1690
3-METHYLPENTANE	0.958	3380
N-HEXANE	1.21	4280
ISOHEPTANE	0.51	2090
3-METHYLHEXANE	0.481	1970
N-HEPTANE	0.607	2490
METHYLCYCLOHEXANE	0.57	2290
2,2,5-TRIMETHYLHEXANE	0.2	1050
N-OCTANE	0.176	823
N-DECANE	3.33	19400
N-UNDECANE	4.5	28800
C9 ALKANE	0.221	1160
C9 ALKANE	6.29	33000
C10+ ALKANE	1.16	6750
C10+ ALKANE	2.28	13300
C10+ ALKANE	3.47	20200
C10+ ALKANE	18.5	108000
OLEFINS		
1-NONENE	10.4	53800
4-NONENE	8.21	42400
A-PINENE	3.01	16800
1-DECENE	5.07	29100
LIMONENE	3.25	18100
1-UNDECENE	6.71	42300
C9 ALKENE	7.8	40300
C9 ALKENE	1.5	7740
C9 ALKENE	0.814	4200
C10+ ALKENE	9.25	53100
C10+ ALKENE	22.2	127000
C10+ ALKENE	23.7	136000
C10+ ALKENE	2.89	16600
C10+ ALKENE	31.5	181000
C10+ ALKENE	19.3	111000
C10+ ALKENE	3.86	22100
C10+ ALKENE	0.762	4370

COMPOUND	CONCENTRATION	
	(PPMV)	(UG/M**3)
TOTAL AROMATICS		
BENZENE	2.35	7510
TOLUENE	181	683000
ETHYLBENZENE	0.389	1690
P-XYLENE/M-XYLENE	1.93	8360
O-XYLENE	27.8	121000
ISOPROPYLBENZENE	1.64	6080
N-PROPYLBENZENE	0.706	3470
M-ETHYLTOLUENE	0.612	3010
P-ETHYLTOLUENE	2	9830
O-ETHYLTOLUENE	32.3	159000
T-BUTYLBENZENE	4.47	24500
1,2,4-TRIMETHYLBENZENE	8.31	40900
ISOBUTYLBENZENE	5.75	31600
1,2,3-TRIMETHYLBENZENE	1.39	6830
INDAN	6.54	31600
M-DIETHYLBENZENE	7.43	40800
N-BUTYLBENZENE	5.04	27700
P-DIETHYLBENZENE	2.14	11700
NAPHTHALENE	0.166	870
C10+ AROMATIC	1.28	7030
C10+ AROMATIC	1.74	9550
C10+ AROMATIC	2.33	12800
C10+ AROMATIC	1.46	8010
C10+ AROMATIC	1.18	6480
C10+ AROMATIC	2.12	11600
C10+ AROMATIC	0.566	3110
TOTAL HALOGENATED HC		
1,2-DICHLOROETHANE	770	3120000
CHLOROBENZENE	76.8	354000
UNIDENTIFIED HALOGENATED HC	0.437	2020
UNIDENTIFIED HALOGENATED HC	0.557	2570
TOTAL OXYGENATED HC(B)		
METHANOL	1.3	1700

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER INLET
SAMPLE CONTROL NO: U-004
SAMPLE TYPE: CANISTER

DATE SAMPLED: 07/13/84
DATE ANALYZED: 07/20/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)	COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	1.07	3780			
UNIDENTIFIED VOC	0.913	3210			
PARAFFINS	45.6	251000			
OLEFINS	160	906000			
TOTAL AROMATICS	303	1280000			
TOTAL HALOGENATED HC	848	3480000			
TOTAL OXYGENATED HC	1.3	1700(B)			
UNIDENTIFIED VOC	1.99	6990(C)			
TOTAL NMHC	1360	5920000			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER INLET
SAMPLE CONTROL NO: U-059
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.537	924
ISOBUTANE	0.124	295
ISOHEXANE	0.036	127
3-METHYLPENTANE	0.0398	140
CYCLOHEXANE	0.192	660
ISOHEPTANE	1.5	6150
3-METHYLHEXANE	1.41	5770
N-HEPTANE	1.77	7260
METHYLCYCLOHEXANE	2.81	11300
N-OCTANE	0.0305	142
C6 ALKANE	0.0432	152
C7 ALKANE	0.421	1730
C7 ALKANE	0.419	1720
C7 ALKANE	0.894	3660
C8 ALKANE	0.0481	225
C10+ ALKANE	0.0234	136
C10+ ALKANE	0.0209	122
C10+ ALKANE	0.0393	229
C10+ ALKANE	0.034	198
C10+ ALKANE	0.0382	222
OLEFINS		
LIMONENE	0.0423	236
TOTAL AROMATICS		
BENZENE	4.5	14400
TOLUENE	5.07	19100
ETHYLBENZENE	0.166	722
P-XYLENE/M-XYLENE	0.433	1880
O-XYLENE	0.158	684
M-ETHYLTOLUENE	0.0446	219
P-ETHYLTOLUENE	0.0633	311
O-ETHYLTOLUENE	0.0418	205
1,2,4-TRIMETHYLBENZENE	0.133	655
M-DIETHYLBENZENE	0.0676	371
C9 AROMATIC	0.203	1000
C10+ AROMATIC	0.135	741

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION *UG/M**3)
TOTAL AROMATICS (CONT'D)		
C10+ AROMATIC	0.208	1140
TOTAL HALOGENATED HC		
CHLOROMETHANE	1.61	3330
METHYLENE CHLORIDE	5.12	17800
CHLOROFORM	16.4	80100
1,2-DICHLOROETHANE	172	696000
CARBON TETRACHLORIDE	0.284	1790
CHLOROBENZENE	3.6	16600
P-DICHLOROBENZENE	0.188	1130
O-DICHLOROBENZENE	0.287	1720
UNIDENTIFIED HALOGENATED HC	0.987	4560
PARAFFINS	10.4	41200
OLEFINS	0.0423	236
TOTAL AROMATICS	11.2	41400
TOTAL HALOGENATED HC	200	823000
TOTAL NMHC	222	906000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER INLET
SAMPLE CONTROL NO: U-093
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.413	712
ISOBUTANE	0.101	239
ISOHEXANE	0.0467	165
3-METHYLPENTANE	0.0383	135
CYCLOHEXANE	1.24	4260
ISOHEPTANE	9.49	38900
N-HEPTANE	11.9	48800
METHYLCYCLOHEXANE	18.4	74000
2,5-DIMETHYLHEXANE	0.0486	227
N-OCTANE	0.0365	170
C7 ALKANE	8.83	36200
C7 ALKANE	2.9	11900
C7 ALKANE	2.87	11800
C7 ALKANE	6.17	25300
C8 ALKANE	0.285	1330
C10+ ALKANE	0.0298	173
C10+ ALKANE	0.14	815
C10+ ALKANE	0.0208	121
C10+ ALKANE	0.047	274
C10+ ALKANE	0.07	407
C10+ ALKANE	0.0477	278
C10+ ALKANE	0.0291	169
C10+ ALKANE	0.0394	229
TOTAL AROMATICS		
BENZENE	26	83100
TOLUENE	5.71	21500
ETHYLBENZENE	0.13	565
P-XYLENE/M-XYLENE	0.375	1630
O-XYLENE	0.133	576
M-ETHYLTOLUENE	0.0472	232
P-ETHYLTOLUENE	0.0654	322
O-ETHYLTOLUENE	0.0436	214
1,2,4-TRIMETHYLBENZENE	0.133	655
C10+ AROMATIC	0.23	1260
C10+ AROMATIC	0.238	1310

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL HALOGENATED HC		
CHLOROMETHANE	1.32	2730
METHYLENE CHLORIDE	3.97	13800
CHLOROFORM	27.4	134000
1,2-DICHLOROETHANE	204	824000
CARBON TETRACHLORIDE	0.249	1570
CHLOROBENZENE	13.2	60900
P-DICHLOROBENZENE	0.182	1090
O-DICHLOROBENZENE	0.365	2190
UNIDENTIFIED HALOGENATED HC	1.17	5420
PARAFFINS	63.2	256000
TOTAL AROMATICS	33.1	111000
TOTAL HALOGENATED HC	251	1050000
TOTAL NMHC	348	1410000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER INLET
SAMPLE CONTROL NO: U-099
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/18/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
CYCLOHEXANE	2.77	9530
ISOHEPTANE	25.9	106000
3-METHYLHEXANE	24.4	100000
N-HEPTANE	26.9	110000
METHYLCYCLOHEXANE	43.7	176000
2,5-DIMETHYLHEXANE	0.169	788
N-OCTANE	0.143	666
C6 ALKANE	0.177	623
C7 ALKANE	7.19	29400
C7 ALKANE	7.01	28700
C7 ALKANE	13.8	56400
C8 ALKANE	0.685	3200
C10+ ALKANE	0.0789	459
C10+ ALKANE	0.112	652
C10+ ALKANE	0.251	1460
OLEFINS		
1-HEPTENE	6.2	24900
B-PINENE	0.189	1050
TOTAL AROMATICS		
BENZENE	21.2	67600
TOLUENE	92.1	347000
1,2,4-TRIMETHYLBENZENE	0.704	3460
C9 AROMATIC	1.26	6170
C10+ AROMATIC	0.531	2910
C10+ AROMATIC	1.06	5820
TOTAL HALOGENATED HC		
METHYLENE CHLORIDE	4.3	14900
CHLOROFORM	81.5	398000
1,2-DICHLOROETHANE	240	972000
CARBON TETRACHLORIDE	0.646	4060
CHLOROBENZENE	0.345	1590
P-DICHLOROBENZENE	0.193	1160
O-DICHLOROBENZENE	1.02	6100

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL HALOGENATED HC (CONT'D)		
UNIDENTIFIED HALOGENATED HC	0.321	1480
UNIDENTIFIED HALOGENATED HC	2.5	11600
PARAFFINS	153	624000
OLEFINS	6.39	26000
TOTAL AROMATICS	117	433000
TOTAL HALOGENATED HC	331	1410000
TOTAL NMHC	607	2490000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-003
SAMPLE TYPE: CANISTER

DATE SAMPLED: 07/17/84
DATE ANALYZED: 07/20/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
2,3-DIMETHYLBUTANE	7.37	26000
ISOHEXANE	0.807	2840
3-METHYLPENTANE	0.837	2950
N-HEXANE	1.58	5580
ISOHEPTANE	0.494	2030
3-METHYLHEXANE	0.607	2490
N-HEPTANE	0.967	3960
METHYLCYCLOHEXANE	0.86	3450
2,2,5-TRIMETHYLHEXANE	0.445	2340
N-OCTANE	1.08	5060
N-DECANE	5.62	32700
N-UNDECANE	4.03	25700
C7 ALKANE	0.364	1490
C7 ALKANE	0.187	767
C9 ALKANE	7.97	41800
C9 ALKANE	2.12	11100
C9 ALKANE	5.6	29400
C9 ALKANE	1.82	9560
C10+ ALKANE	0.79	4600
C10+ ALKANE	0.875	5090
C10+ ALKANE	3.07	17900
C10+ ALKANE	0.696	4050
C10+ ALKANE	0.777	4520
C10+ ALKANE	0.26	1510
C10+ ALKANE	1.11	6460
OLEFINS		
2,4,4-TRIME-2-PENTENE	27.3	125000
C-2-OCTENE	3.44	15800
1-NONENE	8.11	41900
4-NONENE	6.73	34800
A-PINENE	2.23	12400
B-PINENE	9.34	52000
1-DECENE	5.23	30000
LIMONENE	1.88	10500
1-UNDECENE	2.36	14900
C9 ALKENE	0.384	1980
C10+ ALKENE	14	80300

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
OLEFINS (CONT'D)		
C10+ ALKENE	17.6	101000
C10+ ALKENE	1.38	7920
C10+ ALKENE	12.7	72900
C10+ ALKENE	6.86	39400
C10+ ALKENE	2.84	16300
C10+ ALKENE	4.98	28600
C10+ ALKENE	1.38	7920
TOTAL AROMATICS		
BENZENE	2.6	8310
TOLUENE	119	447000
ETHYLBENZENE	3.13	13600
P-XYLENE/M-XYLENE	6.11	26600
STYRENE	2.26	9630
O-XYLENE	8.06	35000
ISOPROPYLBENZENE	2.7	13300
M-ETHYLTOLUENE	1.46	7160
1,3,5-TRIMETHYLBENZENE	2.67	13100
O-ETHYLTOLUENE	29.2	144000
T-BUTYLBENZENE	6.56	36000
1,2,4-TRIMETHYLBENZENE	7.44	36600
ISOBUTYLBENZENE	2.92	16000
1,2,3-TRIMETHYLBENZENE	1.94	9560
INDAN	5.39	26100
M-DIETHYLBENZENE	3.91	21500
P-DIETHYLBENZENE	1.57	8620
NAPHTHALENE	3.83	20100
C10+ AROMATIC	2.27	12500
C10+ AROMATIC	3.38	18600
C10+ AROMATIC	0.896	4920
TOTAL HALOGENATED HC		
1,2-DICHLOROETHANE	770	3120000
CHLOROBENZENE	112	515000
UNIDENTIFIED HALOGENATED HC	93	430000
UNIDENTIFIED HALOGENATED HC	97.3	450000
UNIDENTIFIED HALOGENATED HC	1	4640

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-003
SAMPLE TYPE: CANISTER

DATE SAMPLED: 07/17/84
DATE ANALYZED: 07/20/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)	COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL HALOGENATED HC (CONT'D)					
UNIDENTIFIED HALOGENATED HC	0.963	4450			
UNIDENTIFIED VOC(C)					
UNIDENTIFIED VOC	6.02	21200			
UNIDENTIFIED VOC	0.57	2000			
PARAFFINS	50.3	253000			
OLEFINS	129	694000			
TOTAL AROMATICS	217	920000			
TOTAL HALOGENATED HC	1070	4520000			
UNIDENTIFIED VOC	6.59	23200(C)			
TOTAL NMHC	1480	6420000			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-060A
SAMPLE TYPE: CANISTEP

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-2 VOC	1.57	1800
CYCLOHEXANE	0.175	602
ISOHEPTANE	1.72	7040
3-METHYLHEXANE	1.67	6850
N-HEPTANE	2.21	9070
METHYLCYCLOHEXANE	3.13	12600
N-OCTANE	0.0704	329
N-NONANE	0.111	583
C8 ALKANE	0.0655	306
C10+ ALKANE	0.0451	262
C10+ ALKANE	0.0933	543
C10+ ALKANE	0.0682	397
C10+ ALKANE	0.065	378
C10+ ALKANE	0.228	1330
C10+ ALKANE	0.0417	243
C10+ ALKANE	0.176	1020
C10+ ALKANE	0.0821	478
C10+ ALKANE	0.0839	488
OLEFINS		
C7 ALKENE	0.46	1850
C7 ALKENE	0.453	1820
C7 ALKENE	0.987	3960
TOTAL AROMATICS		
BENZENE	14.8	47300
TOLUENE	18.9	71000
ETHYLBENZENE	0.488	2120
P-XYLENE/M-XYLENE	1.12	4880
O-XYLENE	0.644	2800
M-ETHYLTOLUENE	0.0902	444
P-ETHYLTOLUENE	0.141	694
O-ETHYLTOLUENE	0.234	1150
1,2,4-TRIMETHYLBENZENE	0.177	869
M-DIETHYLBENZENE	0.225	1230
C9 AROMATIC	0.428	2100
C10+ AROMATIC	0.184	1010
TOTAL AROMATICS (CONT'D)		
C10+ AROMATIC	0.18	980
TOTAL HALOGENATED HC		
CHLOROMETHANE	4.73	9770
METHYLENE CHLORIDE	5	17400
CHLOROFORM	16.6	81100
1,2-DICHLOROETHANE	225	911000
CARBON TETRACHLORIDE	0.352	2210
TETRACHLOROETHYLENE	0.0216	146
CHLOROBENZENE	6.47	29800
P-DICHLOROBENZENE	0.0253	152
O-DICHLOROBENZENE	0.0562	338
PARAFFINS	11.6	44300
OLEFINS	1.9	7630
TOTAL AROMATICS	37.6	137000
TOTAL HALOGENATED HC	258	1050000
TOTAL NMHC	309	1240000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-060B
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.623	1070
CYCLOHEXANE	0.183	631
ISOHEPTANE	1.89	7730
3-METHYLHEXANE	1.81	7440
N-HEPTANE	2.5	10200
METHYLCYCLOHEXANE	3.46	13900
N-OCTANE	0.058	271
N-NONANE	0.152	799
N-DECANE	0.045	262
C7 ALKANE	0.51	2090
C7 ALKANE	0.501	2050
C7 ALKANE	1.09	4470
C8 ALKANE	0.0676	316
C10+ ALKANE	0.0501	292
C10+ ALKANE	0.116	675
C10+ ALKANE	0.0875	509
C10+ ALKANE	0.0905	527
C10+ ALKANE	0.0712	414
C10+ ALKANE	0.25	1460
C10+ ALKANE	0.0731	425
C10+ ALKANE	0.111	646
C10+ ALKANE	0.236	1370
C10+ ALKANE	0.0979	570
C10+ ALKANE	0.108	629
C10+ ALKANE	0.0926	539
TOTAL AROMATICS		
BENZENE	15.3	48900
TOLUENE	20.3	76400
ETHYLBENZENE	0.263	1140
P-XYLENE/M-XYLENE	0.969	4210
O-XYLENE	0.718	3120
M-ETHYLTOLUENE	0.102	504
P-ETHYLTOLUENE	0.166	814
O-ETHYLTOLUENE	0.264	1300
1,2,4-TRIMETHYLBENZENE	0.214	1050
M-DIETHYLBENZENE	0.3	1650
C9 AROMATIC	0.38	1870

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL AROMATICS (CONT'D)		
C10+ AROMATIC	0.273	1500
C10+ AROMATIC	0.205	1130
TOTAL HALOGENATED HC		
CHLOROMETHANE	4.9	10100
METHYLENE CHLORIDE	5.19	18000
CHLOROFORM	15.5	75700
1,2-DICHLOROETHANE	237	960000
CARBON TETRACHLORIDE	0.347	2180
CHLOROBENZENE	6.65	30600
P-DICHLOROBENZENE	0.0662	398
O-DICHLOROBENZENE	0.155	933
UNIDENTIFIED HALOGENATED HC	0.427	1970
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	0.213	750
PARAFFINS	14.3	59300
TOTAL AROMATICS	39.5	144000
TOTAL HALOGENATED HC	270	1100000
UNIDENTIFIED VOC	0.213	750(C)
TOTAL NMHC	324	1300000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-094
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/17/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.43	740
ISOBUTANE	0.104	247
ISOHEXANE	0.0418	147
3-METHYLPENTANE	0.0393	139
CYCLOHEXANE	1.43	4930
ISOHEPTANE	7.66	31400
2,2,4-TRIMETHYLPENTANE	0.0286	134
N-HEPTANE	8.11	33300
METHYLCYCLOHEXANE	14.2	57000
2,5-DIMETHYLHEXANE	0.0286	134
N-OCTANE	0.0403	188
C7 ALKANE	6.87	28200
C7 ALKANE	2.41	9890
C7 ALKANE	2.39	9780
C7 ALKANE	4.93	20200
C8 ALKANE	0.214	990
C10+ ALKANE	0.0293	171
C10+ ALKANE	0.0269	157
C10+ ALKANE	0.101	580
C10+ ALKANE	0.11	640
C10+ ALKANE	0.0617	359
C10+ ALKANE	0.2	1160
C10+ ALKANE	0.0414	241
C10+ ALKANE	0.147	856
C10+ ALKANE	0.104	605
C10+ ALKANE	0.044	256
OLEFINS		
C10+ ALKENE	0.0627	360
C10+ ALKENE	0.0451	259
C10+ ALKENE	0.042	241
TOTAL AROMATICS		
BENZENE	22.8	72900
TOLUENE	7.54	28400
P-XYLENE/M-XYLENE	0.674	2930
O-XYLENE	0.256	1110

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL AROMATICS (CONT'D)		
M-ETHYLTOLUENE	0.0784	386
P-ETHYLTOLUENE	0.128	628
O-ETHYLTOLUENE	0.0382	188
1,2,4-TRIMETHYLBENZENE	0.282	1390
M-DIETHYLBENZENE	0.0573	315
P-DIETHYLBENZENE	0.0375	206
C10+ AROMATIC	0.128	703
C10+ AROMATIC	0.126	692
TOTAL HALOGENATED HC		
CHLOROMETHANE	1.83	3780
METHYLENE CHLORIDE	4.24	14700
CHLOROFORM	25.9	126000
1,2-DICHLOROETHANE	205	828000
CARBON TETRACHLORIDE	0.259	1630
TRICHLOROETHYLENE + BROMODICHLOROMETHANE	0.0169	90.0
CHLOROBENZENE	13.3	61300
P-DICHLOROBENZENE	0.162	976
O-DICHLOROBENZENE	0.612	3680
UNIDENTIFIED HALOGENATED HC	0.457	2110
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	0.332	1170
PARAFFINS	49.8	202000
OLEFINS	0.15	860
TOTAL AROMATICS	32.2	110000
TOTAL HALOGENATED HC	251	1040000
UNIDENTIFIED VOC	0.332	1170(C)
TOTAL NMHC	334	1360000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-100
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/18/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	(UG/M**3)
PARAFFINS		
CYCLOHEXANE	3.03	10400
ISOHEPTANE	26.7	109000
3-METHYLHEXANE	24.9	102000
N-HEPTANE	25.9	106000
METHYLCYCLOHEXANE	43.6	175000
2,5-DIMETHYLHEXANE	0.151	706
N-OCTANE	0.298	1390
N-NONANE	0.209	1100
N-DECANE	0.128	745
N-UNDECANE	0.582	3720
C6 ALKANE	0.131	461
C7 ALKANE	7.51	30800
C7 ALKANE	13.5	55100
C7 ALKANE	7.34	30100
C8 ALKANE	0.684	3190
C9 ALKANE	0.236	1240
C10+ ALKANE	0.199	1160
C10+ ALKANE	0.924	5380
C10+ ALKANE	0.0878	511
C10+ ALKANE	0.321	1870
C10+ ALKANE	1.07	6230
C10+ ALKANE	0.113	658
C10+ ALKANE	1.09	6340
C10+ ALKANE	1.47	8560
C10+ ALKANE	0.391	2280
C10+ ALKANE	0.183	1070
C10+ ALKANE	1.63	9490
C10+ ALKANE	0.297	1730
C10+ ALKANE	1.15	6690
C10+ ALKANE	0.548	3190
C10+ ALKANE	0.817	4750
C10+ ALKANE	0.659	3840
C10+ ALKANE	0.448	2610
C10+ ALKANE	0.272	1580
C10+ ALKANE	0.365	2120
C10+ ALKANE	0.169	984
C10+ ALKANE	0.129	751

COMPOUND	CONCENTRATION (PPMV)	(UG/M**3)
OLEFINS		
A-PINENE	0.301	1680
1-DECENE	0.239	1370
1-UNDECENE	0.528	3330
TOTAL AROMATICS		
BENZENE	24.8	79300
TOLUENE	54.1	204000
P-XYLENE/M-XYLENE	2.08	9010
O-XYLENE	1.63	7060
M-ETHYLTOLUENE	0.568	2790
P-ETHYLTOLUENE	0.684	3360
O-ETHYLTOLUENE	0.844	4150
1,2,4-TRIMETHYLBENZENE	1.01	4970
INDAN	0.707	3420
INDENE	0.268	1270
M-DIETHYLBENZENE	0.455	2500
P-DIETHYLBENZENE	0.27	1480
C9 AROMATIC	1.63	8030
C10+ AROMATIC	0.305	1670
C10+ AROMATIC	0.429	2350
TOTAL HALOGENATED HC		
CHLOROMETHANE	9.19	19000
METHYLENE CHLORIDE	2.07	7190
CHLOROFORM	34	166000
1,2-DICHLOROETHANE	355	1440000
CARBON TETRACHLORIDE	0.244	1530
CHLOROBENZENE	8.8	40500
P-DICHLOROBENZENE	0.0335	201
O-DICHLOROBENZENE	0.115	690
UNIDENTIFIED HALOGENATED HC	0.17	787
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	31.2	110000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

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        FIELD ID NO:  CARBON ADSORBER OUTLET                                              DATE SAMPLED:    08/18/84
        SAMPLE CONTROL NO:  U-100                                                         DATE ANALYZED:   09/01/84
        SAMPLE TYPE:   CANISTER
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                                             CONCENTRATION                                                CONCENTRATION
     COMPOUND                              (PPMV)    (UG/M**3)         COMPOUND                         (PPMV)    (UG/M**3)
     --------                              -------------------         --------                         -------------------

PARAFFINS                                      167    703000
OLEFINS                                       1.07      6380
TOTAL AROMATICS                               89.8    335000
TOTAL HALOGENATED HC                           409   1670000
UNIDENTIFIED VOC                              31.2    110000(C)

TOTAL NMHC                                     698   2830000




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(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

 *   UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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FIELD ID NO: CARBON ADSORBER OUTLET
SAMPLE CONTROL NO: U-129
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/19/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.47	809
CYCLOHEXANE	0.177	608
ISOHEPTANE	2.81	11500
3-METHYLHEXANE	3.31	13600
N-HEPTANE	13.3	54700
METHYLCYCLOHEXANE	18.7	75200
2,5-DIMETHYLHEXANE	0.276	1290
2,3,4-TRIMETHYLPENTANE	0.0866	405
3-METHYLHEPTANE	0.085	397
N-OCTANE	0.12	561
N-DECANE	0.073	425
N-UNDECANE	0.973	6220
C7 ALKANE	0.734	3010
C7 ALKANE	0.764	3130
C7 ALKANE	2	8200
C8 ALKANE	0.514	2400
C8 ALKANE	0.0345	161
C9 ALKANE	0.0498	261
C10+ ALKANE	0.0531	309
C10+ ALKANE	1.71	9950
C10+ ALKANE	0.137	797
C10+ ALKANE	1.24	7220
C10+ ALKANE	1.4	8150
C10+ ALKANE	0.876	5100
C10+ ALKANE	0.43	2500
C10+ ALKANE	3	17500
C10+ ALKANE	0.678	3950
C10+ ALKANE	2.54	14800
C10+ ALKANE	2.34	13600
C10+ ALKANE	0.867	5050
C10+ ALKANE	0.568	3310
C10+ ALKANE	0.632	3680
C10+ ALKANE	0.269	1570
C10+ ALKANE	0.598	3480
C10+ ALKANE	0.534	3110
C10+ ALKANE	0.337	1960
C10+ ALKANE	0.22	1280
C10+ ALKANE	0.137	797
C10+ ALKANE	0.123	716

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS (CONT'D)		
C10+ ALKANE	0.128	745
C10+ ALKANE	0.0259	151
OLEFINS		
4-NONENE	0.052	268
A-PINENE	0.0294	164
B-PINENE	0.121	674
1-DECENE	0.239	1370
LIMONENE	0.27	1500
1-UNDECENE	0.635	4010
C10+ ALKENE	1.25	7170
C10+ ALKENE	0.625	3590
C10+ ALKENE	0.35	2010
C10+ ALKENE	0.499	2860
C10+ ALKENE	0.373	2140
C10+ ALKENE	0.326	1870
C10+ ALKENE	0.225	1290
TOTAL AROMATICS		
BENZENE	9.5	30300
TOLUENE	24	90400
ETHYLBENZENE	0.296	1290
P-XYLENE/M-XYLENE	2.46	10700
STYRENE	1.06	4490
M-ETHYLTOLUENE	0.411	2020
P-ETHYLTOLUENE	0.826	4060
O-ETHYLTOLUENE	0.237	1160
1,2,4-TRIMETHYLBENZENE	1.32	6500
P-ISOPROPYLTOLUENE	0.28	1540
INDENE	0.268	1270
M-DIETHYLBENZENE	0.79	4340
P-DIETHYLBENZENE	0.587	2780
C10+ AROMATIC	0.38	2090
C10+ AROMATIC	0.184	1010
C10+ AROMATIC	0.767	4210
C10+ AROMATIC	0.203	1110

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

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        FIELD ID NO:  CARBON ADSORBER OUTLET
        SAMPLE CONTROL NO:  U-129                                                   DATE SAMPLED:    08/19/84
        SAMPLE TYPE:   CANISTER                                                     DATE ANALYZED:   09/01/84
--------------------------------------------------------------------------------------------------------------

        COMPOUND                           CONCENTRATION                                       CONCENTRATION
        --------                          (PPMV)   (UG/M**3)       COMPOUND                   (PPMV)   (UG/M**3)
                                          ------------------       --------                   ------------------
 TOTAL HALOGENATED HC
 --------------------
  CHLOROMETHANE                            0.469      969
  TRICHLOROFLOROMETHANE                    0.0551     308(A)
  METHYLENE CHLORIDE                       0.0915     318
  CHLOROFORM                               0.572     2790
  1,2-DICHLOROETHANE                      15.3      61700
  TETRACHLOROETHYLENE                      0.0239     162
  CHLOROBENZENE                           26.3     121000
  M-DICHLOROBENZENE                        0.538     3240
  P-DICHLOROBENZENE                        0.198     1190
  O-DICHLOROBENZENE                        1.98     11900
  UNIDENTIFIED HALOGENATED HC              0.593     2740

 PARAFFINS                                63.4     293000
 OLEFINS                                   4.99     28900
 TOTAL AROMATICS                          43.5     169000
 TOTAL HALOGENATED HC                     46.1     206000

 TOTAL NMHC                              158       697000




--------------------------------------------------------------------------------------------------------------
(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

  *  UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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Appendix M
Volumetric Flow Rate
Measurement

D01 (1-3) PLANT NAME OR I.D. Upjohn

SAMPLING LOCATION CAS Outlet SAMPLING IDENT. Velocity Traverse #5

D02 (1-3) DATE 8-18-84 (4:6) (MMDDYY) TIME START 0835 (11:4) (HHMM) TIME FINISH ______ (18:4) (HHMM)

DUCT DIMENSIONS — (25:5) X — (32:5) FT. OR DIAMETER 1.5 (39:5) FT.

PTCF ______ (46:5) % H_2O ______ (53:5)

D03 (1-3) BAR PRESS. ______ (4:5) "HG % CO ______ (11:5) % N_2 ______ (18:5)

STATIC PRESS. <.005 (25:5) "H_2O ______ (32) % CO_2 ______ (39:5) % H_2 ______ (46:5)

OPERATOR INITIALS BME, TPN (53:5) % O_2 ______ (60:5) % CH_4 ______ (67:5)

Duct 1

	Pt.	Stack Temperature °F			Velocity Pressure "H_2O			Other (EPA-3 Gas Collection time,sec)		
		#1	#2	Ave.	#1	#2	Ave.	#1	#2	Ave.
D04	1				.15	.18	0.165			
D05	2				.205	.22	0.212			
D06	3				.24	.24	0.24			
D07	4				.275	.285	0.28			
D08	5				.31	.32	0.315			
D09	6				.31	.30	0.305			
Duct 2 D10										
D11	1				.155	.17	0.162			
D12	2				.21	.215	0.212			
D13	3				.23	.23	0.23			
D14	4				.22	.22	0.22			
D15	5				.235	.25	0.242			
D16	6				.27	.27	0.27			
D17										
D18										
D19										
D20										
D21										
	(4:2)	(11:5)	(18:5)	(25:5)	(32:5)	(39:5)	(46:5)	(53:5)	(60:5)	(67:5)

WEATHER cool, windy, partly cloudy

D22 REMARKS wet bulb = dry bulb = 89°F 100% RH

Inlet wet bulb = Inlet dry bulb = 92°F

VELOCITY DETERMINATION

Input: Pitot ΔP (ΔP, in. H_2O); stack temperature (T_s, °R); wet molecular weight of gas (M_s), from gas analysis; absolute stack pressure (P_s, in. Hg); pitot tube correction factor (PTCF), usually 0.84.

Preliminary Calculations:

1) Average $\sqrt{\Delta P} = \frac{\Sigma\sqrt{\Delta P}}{N} =$ 0.485

where N is the number of points measured. For one point, just use $\sqrt{\Delta P}$.

2) Wet molecular weight (M_s) (e.g., using Orsat and EPA Method 4 data), g/g-mole

$M_s = [44(\text{Dry }\%CO_2) + 32(\text{Dry }\%O_2) + 28(\text{Dry }\%CO) + 28(\text{Dry }\%N_2)] \times (.01)$
$\times (1\text{-Moisture Fraction}) + 18(\text{Moisture Fraction})$
$= [44 \times \_\_\_ + 32 \times \_\_\_ + 28 \times \_\_\_ + 28 \times \_\_\_] \times (.01)(1-MF) + 18(MF)$
= 28.49 g/g-mole

MF = 0.0461

3) Absolute Stack Pressure (P_s), "Hg

P_s = (Barometric Pressure, "Hg) + (Stack Static Pressure, "H_2O)
= (29.92)"Hg + (0.005)"H_2O (0.07355)
= 29.92 "Hg

4) Absolute Stack Temperature (T_s), °R

T_s = (Stack Temperature, °F) + 460
= (89)°F + 460
= 549 °R

Final Calculation (average stack gas velocity, V_s, ft/sec):

$$V_s = (85.49)(\text{PTCF})\sqrt{\frac{(T_s,\ ^\circ R)}{(M_s)(P_s,\ "Hg)}}\ (\text{Ave }\sqrt{\Delta P})$$

$$= (85.49)(0.84)\sqrt{\frac{(549)}{(28.49)(29.92)}}\ (0.485)$$

= 27.95 ft/sec

Date 9/25/84 Time ______ Signature Thomas P. Nelson

D01 (1-3) PLANT NAME OR I.D. Upjohn

SAMPLING LOCATION C.A.S. Outlet SAMPLING IDENT. ____

D02 (1-3) DATE 8-16-84 (4:6) (MMDDYY) TIME START 1705 (11:4) (HHMM) TIME FINISH ____ (18:4) (HHMM)

DUCT DIMENSIONS – (25:3) X – (32:3) FT. OR DIAMETER 1.5 (39:3) FT.

PTCF ____ (46:3) % H_2O ____ (53:3)

D03 (1-3) BAR PRESS. ____ (4:3) "HG % CO ____ (11:3) % N_2 ____ (18:3)

STATIC PRESS. .07 (25:3) "H_2O ____ (32) % CO_2 ____ (39:3) % H_2 ____ (46:3)

OPERATOR INITIALS BME, TPN (53:3) % O_2 ____ (60:3) % CH_4 ____ (67:3)

		Pt.	Stack Temperature °F			Velocity Pressure "H_2O			Other (EPA-3 Gas Collection time,sec)		
			#1	#2	Ave.	#1	#2	Ave.	#1	#2	Ave.
#1	D04	1				.175	.165	0.17			
	D05	2				.22	.22	0.22			
	D06	3				.235	.22	0.228			
	D07	4				.27	.31	0.29			
	D08	5				.30	.30	0.30			
	D09	6				.29	.295	0.293			
	D10										
#2	D11	1				.17	.195	0.183			
	D12	2				.21	.23	0.225			
	D13	3				.24	.235	0.237			
	D14	4				.21	.21	0.21			
	D15	5				.30	.295	0.30			
	D16	6				.30	.30	0.30			
	D17										
	D18										
	D19										
	D20										
	D21										
		(4:2)	(11:3)	(18:3)	(25:3)	(32:3)	(39:3)	(46:3)	(53:3)	(60:3)	(67:3)

WEATHER Clear, sunny, 93°F

D22 REMARKS wet bulb = 99°F, dry bulb = 99°F, RH = 100%

VELOCITY DETERMINATION

Input: Pitot ΔP (ΔP, in. H_2O); stack temperature (T_s, °R); wet molecular weight of gas (M_s), from gas analysis; absolute stack pressure (P_s, in. Hg); pitot tube correction factor (PTCF), usually 0.84.

Preliminary Calculations:

1) Average $\sqrt{\Delta P}$ = $\frac{\Sigma\sqrt{\Delta P}}{N}$ = 0.494

where N is the number of points measured. For one point, just use $\sqrt{\Delta P}$.

2) Wet molecular weight (M_s) (e.g., using Orsat and EPA Method 4 data), g/g-mole

M_s = [44(Dry %CO_2) + 32(Dry %O_2) + 28(Dry %CO) + 28(Dry %N_2)] × (.01)
× (1-Moisture Fraction) + 18(Moisture Fraction)
= [44 ×______ + 32 ×______ + 28 ×______ + 28 ×______] × (.01)(1-MF) + 18(MF)
= 28.33 g/g-mole

MF = 0.0605

3) Absolute Stack Pressure (P_s), "Hg

P_s = (Barometric Pressure, "Hg) + (Stack Static Pressure, "H_2O)
= (29.92)"Hg + (0.07)"H_2O (0.07355)
= 29.92 "Hg

4) Absolute Stack Temperature (T_s), °R

T_s = (Stack Temperature, °F) + 460
= (99)°F + 460
= 559 °R

Final Calculation (average stack gas velocity, V_s, ft/sec):

$$V_s = (85.49)(\text{PTCF}) \sqrt{\frac{(T_s, \text{°R})}{(M_s)(P_s, \text{"Hg})}} \, (\text{Ave } \sqrt{\Delta P})$$

$$= (85.49)(0.84) \sqrt{\frac{(559)}{(28.33)(29.92)}} \, (0.494)$$

= 28.81 ft/sec

Date 9/25/84 Time ______ Signature Thomas P. Wilson

001 (1-3) PLANT NAME OR I.D. Upjohn

SAMPLING LOCATION C.A.S. Outlet SAMPLING IDENT. ____

002 (1-3) DATE 8-16-84 (4:6) (MMDDYY) TIME START 0850 (11:4) (HHMM) TIME FINISH ____ (18:4) (HHMM)

DUCT DIMENSIONS — (25:3) X — (32:3) FT. OR DIAMETER 1.5 (39:3) FT.

PTCF ____ (46:3) % H_2O ____ (53:3)

003 (1-3) BAR PRESS. ____ (4:3) "HG % CO ____ (11:3) % N_2 ____ (18:3)

STATIC PRESS. <.005 (25:3) "H_2O ____ (32) % CO_2 ____ (39:3) % H_2 ____ (46:3)

OPERATOR INITIALS BME TAN (53:3) % O_2 ____ (60:3) % CH_4 ____ (67:3)

	Pt.	Stack Temperature °F			Velocity Pressure "H_2O			Other (EPA-1 Gas Collection time,sec)		
		#1	#2	Ave.	#1	#2	Ave.	#1	#2	Ave.
#1 004	1				.205	.20	0.205			
005	2				.22	.225	0.22			
006	3				.23	.24	0.235			
007	4				.30	.29	0.295			
008	5				.32	.315	0.315			
009	6				.31	.30	0.305			
010										
#2 011	1				.19	.19	0.19			
012	2				.22	.22	0.22			
013	3				.23	.23	0.23			
014	4				.21	.22	0.215			
015	5				.27	.285	0.278			
016	6				.28	.285	0.283			
017										
018										
019										
020										
021										
	(4:2)	(11:3)	(18:3)	(25:3)	(32:3)	(39:3)	(46:3)	(53:3)	(60:3)	(67:3)

WEATHER Clear, sunny, ~80°

022 REMARKS Wet bulb = 93°F, dry bulb = 93°F R.H. = 100%

VELOCITY DETERMINATION

Input: Pitot ΔP (ΔP, in. H_2O); stack temperature (T_s, °R); wet molecular weight of gas (M_s), from gas analysis; absolute stack pressure (P_s, in. Hg); pitot tube correction factor (PTCF), usually 0.84.

Preliminary Calculations:

1) Average $\sqrt{\Delta P} = \frac{\Sigma\sqrt{\Delta P}}{N} =$ 0.498

where N is the number of points measured. For one point, just use $\sqrt{\Delta P}$.

2) Wet molecular weight (M_s) (e.g., using Orsat and EPA Method 4 data), g/g-mole

$M_s = [44(\text{Dry }\%CO_2) + 32(\text{Dry }\%O_2) + 28(\text{Dry }\%CO) + 28(\text{Dry }\%N_2)] \times (.01)$
$\times$ (1-Moisture Fraction) + 18(Moisture Fraction)
$= [44 \times \_\_\_\_ + 32 \times \_\_\_\_ + 28 \times \_\_\_\_ + 28 \times \_\_\_\_] \times (.01)(1\text{-MF}) + 18(\text{MF})$
= 28.43 g/g-mole

MF = 0.0519

3) Absolute Stack Pressure (P_s), "Hg

P_s = (Barometric Pressure, "Hg) + (Stack Static Pressure, "H_2O)
= (29.92)"Hg + (0.005)"H_2O (0.07355)
= 29.42 "Hg

4) Absolute Stack Temperature (T_s), °R

T_s = (Stack Temperature, °F) + 460
= (93)°F + 460
= 553 °R

Final Calculation (average stack gas velocity, V_s, ft/sec):

$$V_s = (85.49)(\text{PTCF}) \sqrt{\frac{(T_s, °R)}{(M_s)(P_s, \text{"Hg})}} \; (\text{Ave } \sqrt{\Delta P})$$

$$= (85.49)(0.84) \sqrt{\frac{(553)}{(28.43)(29.92)}} \; (0.498)$$

= 28.83 ft/sec

Date 9/25/84 Time ________ Signature Thomas P. Wilson

D01 (1-3) PLANT NAME OR I.D. Upjohn

SAMPLING LOCATION CAS Outlet SAMPLING IDENT. ______

D02 (1-3) DATE 8-17-84 (6:6) (MMDDYY) TIME START 1655 (11:4) (HHMM) TIME FINISH ______ (18:4) (HHMM)

DUCT DIMENSIONS — (25:3) X — (32:3) FT. OR DIAMETER 1.5 (39:3) FT.

PTCF ______ (46:3) % H_2O ______ (53:3)

D03 (1-3) BAR PRESS. ______ (6:3) "HG % CO ______ (11:3) % N_2 ______ (18:3)

STATIC PRESS. 0.14 (25:3) "H_2O ______ (32) % CO_2 ______ (39:3) % H_2 ______ (46:3)

OPERATOR INITIALS TPN, BME (53:3) % O_2 ______ (60:3) % CH_4 ______ (67:3)

		Stack Temperature °F			Velocity Pressure "H_2O			Other (EPA-1 Gas Collection time,sec)		
	Pt.	#1	#2	Ave.	#1	#2	Ave.	#1	#2	Ave.
*1 D04	1				.20	.185	0.193			
D05	2				.22	.24	0.23			
D06	3				.25	.25	0.25			
D07	4				.28	.28	0.28			
D08	5				.325	.34	0.332			
D09	6				.33	.34	0.335			
D10										
*2 D11	1				.18	.17	0.175			
D12	2				.235	.23	0.233			
D13	3				.28	.28	0.28			
D14	4				.26	.22	0.24			
D15	5				.27	.28	0.275			
D16	6				.30	.33	0.315			
D17										
D18										
D19										
D20										
D21										
	(6:2)	(11:3)	(18:3)	(25:3)	(32:3)	(39:3)	(46:3)	(53:3)	(60:3)	(67:3)

WEATHER windy, cool, sunny

D22 REMARKS wet bulb = 97°F, dry bulb = 97°F RH = 100%

VELOCITY DETERMINATION

Input: Pitot ΔP (ΔP, in. H_2O); stack temperature (T_s, °R); wet molecular weight of gas (M_s), from gas analysis; absolute stack pressure (P_s, in. Hg); pitot tube correction factor (PTCF), usually 0.84.

Preliminary Calculations:

1) Average $\sqrt{\Delta P} = \frac{\Sigma\sqrt{\Delta P}}{N}$ = 0.509

where N is the number of points measured. For one point, just use $\sqrt{\Delta P}$.

2) Wet molecular weight (M_s) (e.g., using Orsat and EPA Method 4 data), g/g-mole

M_s = [44(Dry %CO_2) + 32(Dry %O_2) + 28(Dry %CO) + 28(Dry %N_2)] × (.01)
× (1-Moisture Fraction) + 18(Moisture Fraction)
= [44 ×______ + 32 ×______ + 28 ×______ + 28 ×______] × (.01)(1-MF) + 18(MF)
= 28.37 g/g-mole

MF = 0.0577

3) Absolute Stack Pressure (P_s), "Hg

P_s = (Barometric Pressure, "Hg) + (Stack Static Pressure, "H_2O)
= (29.92)"Hg + (0.14)"H_2O (0.07355)
= 29.93 "Hg

4) Absolute Stack Temperature (T_s), °R

T_s = (Stack Temperature, °F) + 460
= (97)°F + 460
= 557 °R

Final Calculation (average stack gas velocity, V_s, ft/sec):

$$V_s = (85.49)(\text{PTCF})\sqrt{\frac{(T_s,\ {}^\circ R)}{(M_s)(P_s,\ \text{"Hg})}}\ (\text{Ave }\sqrt{\Delta P})$$

$$= (85.49)(0.84)\sqrt{\frac{(557)}{(28.37)(29.93)}}\ (0.509)$$

= 29.60 ft/sec

Date 9/25/84 Time ________ Signature Thomas P. [illegible]

D01 (1-3) PLANT NAME OR I.D. Upjohn

SAMPLING LOCATION CAI Outlet SAMPLING IDENT. ______

D02 (1-3) DATE 8-17-84 (4:6) (MMDDYY) TIME START 0825 (11:4) (HHMM) TIME FINISH ______ (18:4) (HHMM)

DUCT DIMENSIONS — (25:3) X — (32:3) FT. OR DIAMETER 1.5 (39:3) FT.

PTCF ______ (46:3) % H_2O ______ (53:3)

D03 (1-3) BAR PRESS. 0.10 (4:3) "HG % CO ______ (11:3) % N_2 ______ (18:3)

STATIC PRESS. ______ (25:3) "H_2O ______ (32) % CO_2 ______ (39:3) % H_2 ______ (46:3)

OPERATOR INITIALS RMS / TPN (53:3) % O_2 ______ (60:3) % CH_4 ______ (67:3)

		Pt.	Stack Temperature °F			Velocity Pressure "H_2O			Other (EPA-3 Gas Collection time,sec		
			#1	#2	Ave.	#1	#2	Ave.	#1	#2	Ave.
#1	D04	1				.18	.20	.19			
	D05	2				.205	.225	.215			
	D06	3				.245	.235	.24			
	D07	4				.28	.29	.285			
	D08	5				.31	.33	.32			
	D09	6				.31	.31	.31			
	D10										
#2	D11	1				.17	.19	.18			
	D12	2				.22	.22	.22			
	D13	3				.24	.24	.24			
	D14	4				.23	.235	.23			
	D15	5				.28	.29	.285			
	D16	6				.31	.31	.31			
	D17										
	D18										
	D19										
	D20										
	D21										
		(4:2)	(11:3)	(18:3)	(25:3)	(32:3)	(39:3)	(46:3)	(53:3)	(60:3)	(67:3)

WEATHER clear, sunny, cool

D22 REMARKS Wet bulb = 91°F Dry bulb = 91°F RH = 100%

VELOCITY DETERMINATION

Input: Pitot ΔP (ΔP, in. H_2O); stack temperature (T_s, °R); wet molecular weight of gas (M_s), from gas analysis; absolute stack pressure (P_s, in. Hg); pitot tube correction factor (PTCF), usually 0.84.

Preliminary Calculations:

1) Average $\sqrt{\Delta P} = \frac{\Sigma\sqrt{\Delta P}}{N}$ = 0.500

where N is the number of points measured. For one point, just use $\sqrt{\Delta P}$.

2) Wet molecular weight (M_s) (e.g., using Orsat and EPA Method 4 data), g/g-mole

M_s = [44(Dry %CO_2) + 32(Dry %O_2) + 28(Dry %CO) + 28(Dry %N_2)] × (.01)
× (1-Moisture Fraction) + 18(Moisture Fraction)
= [44 ×______ + 32 ×______ + 28 ×______ + 28 ×______] × (.01)(1-MF) + 18(MF)
= 28.48 g/g-mole

MF = 0.0476

3) Absolute Stack Pressure (P_s), "Hg

P_s = (Barometric Pressure, "Hg) + (Stack Static Pressure, "H_2O)
= (29.92)"Hg + (0.10)"H_2O (0.07355)
= 29.93 "Hg

4) Absolute Stack Temperature (T_s), °R

T_s = (Stack Temperature, °F) + 460
= (91)°F + 460
= 551 °R

Final Calculation (average stack gas velocity, V_s, ft/sec):

$$V_s = (85.49)(\text{PTCF})\sqrt{\frac{(T_s,\ ^\circ R)}{(M_s)(P_s,\ "Hg)}}\ (\text{Ave}\ \sqrt{\Delta P})$$

$$= (85.49)(0.84)\sqrt{\frac{(551)}{(28.48)(29.93)}}\ (0.500)$$

= 28.67 ft/sec

Date 9/25/84 Time ________ Signature Thomas P. Nelson

Appendix N
Analytical Results for Carbon Bed Sample

FIELD ID NO: CARBON SAMPLE FROM BED
SAMPLE CONTROL NO: U-076
SAMPLE TYPE: SOLID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 10/29/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
N-PENTANE	6800	8.18
3-METHYLPENTANE	1000	1.2
N-HEXANE	1520	1.82
CYCLOHEXANE	852	0.996
ISOHEPTANE	19700	23.5
N-HEPTANE	29000	34.6
METHYLCYCLOHEXANE	46600	54.5
3-METHYLHEPTANE	13800	16.4
2,2,5-TRIMETHYLHEXANE	14300	19.1
N-DECANE	88900	105
N-UNDECANE	296000	350
C6 ALKANE	3360	4.02
C7 ALKANE	3730	4.45
C7 ALKANE	10200	12.2
C7 ALKANE	41700	49.7
C7 ALKANE	10800	12.9
C8 ALKANE	963	1.15
C8 ALKANE	1710	2.03
C9 ALKANE	1420	1.69
C9 ALKANE	2830	3.36
C10+ ALKANE	4230	5.02
C10+ ALKANE	8180	9.7
C10+ ALKANE	25200	29.9
C10+ ALKANE	221000	262
C10+ ALKANE	156000	185
C10+ ALKANE	587000	696
C10+ ALKANE	398000	472
C10+ ALKANE	243000	288
C10+ ALKANE	111000	132
C10+ ALKANE	356000	422
C10+ ALKANE	275000	326
C10+ ALKANE	378000	448
OLEFINS		
4-NONENE	17300	20.2
A-PINENE	18500	21
B-PINENE	36700	41.7
1-DECENE	122000	143
OLEFINS (CONT'D)		
LIMONENE	90100	102
1-UNDECENE	138000	161
C10+ ALKENE	337000	394
C10+ ALKENE	499000	583
C10+ ALKENE	127000	148
C10+ ALKENE	170000	199
C10+ ALKENE	166000	194
C10+ ALKENE	165000	193
C10+ ALKENE	121000	141
TOTAL AROMATICS		
BENZENE	145000	157
TOLUENE	1090000	1190
ETHYLBENZENE	42100	46.6
P-XYLENE/M-XYLENE	610000	675
STYRENE	512000	555
ISOPROPYLBENZENE	8070	8.98
M-ETHYLTOLUENE	238000	265
P-ETHYLTOLUENE	572000	637
1,3,5-TRIMETHYLBENZENE	193000	215
1,2,4-TRIMETHYLBENZENE	1500000	1670
INDENE	80600	86.7
M-DIETHYLBENZENE	401000	448
N-BUTYLBENZENE	353000	395
P-DIETHYLBENZENE	276000	309
NAPHTHALENE	354000	378
C9 AROMATIC	9220	10.3
C10+ AROMATIC	139000	155
C10+ AROMATIC	79700	89.1
C10+ AROMATIC	997000	1110
C10+ AROMATIC	2740000	3070
C10+ AROMATIC	308000	344
C10+ AROMATIC	53600	59.9
C10+ AROMATIC	384000	429
C10+ AROMATIC	545000	609

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

FIELD ID NO: CARBON SAMPLE FROM PED
SAMPLE CONTROL NO: U-976
SAMPLE TYPE: SOLID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 10/29/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
TOTAL HALOGENATED HC		
METHYLENE CHLORIDE	6780	48
CHLOROFORM	3590	35.7
1,2-DICHLOROETHANE	131000	540
1,1,1-TRICHLOROETHANE	216	1.2
CARBON TETRACHLORIDE	248	3.18
TETRACHLOROETHYLENE	341	2.36
CHLOROBENZENE	2740000	4280
M-CHLOROTOLUENE	1080	1.63
P-CHLOROTOLUENE	1000	1.51
M-DICHLOROBENZENE	339000	692
P-DICHLOROBENZENE	1310	2.67
O-DICHLOROBENZENE	1010000	2070
UNIDENTIFIED HALOGENATED HC	224	0.703
UNIDENTIFIED HALOGENATED HC	1890	5.93
UNIDENTIFIED HALOGENATED HC	132	0.414
UNIDENTIFIED HALOGENATED HC	175	0.549
UNIDENTIFIED HALOGENATED HC	2630	8.26
UNIDENTIFIED HALOGENATED HC	4600	14.4
UNIDENTIFIED HALOGENATED HC	762	2.39
UNIDENTIFIED HALOGENATED HC	1880	5.9
UNIDENTIFIED HALOGENATED HC	1400	4.39
UNIDENTIFIED HALOGENATED HC	1690000	5300
UNIDENTIFIED HALOGENATED HC	3450	10.8
UNIDENTIFIED HALOGENATED HC	781	2.45
UNIDENTIFIED HALOGENATED HC	612	1.92
UNIDENTIFIED HALOGENATED HC	165000	518
UNIDENTIFIED HALOGENATED HC	3950	12.4
UNIDENTIFIED HALOGENATED HC	1870	5.87
TOTAL OXYGENATED HC(B)		
2-PROPANOL	2810	4.69
SULFUR SPECIES		
ETHYL MERCAPTAN	2140	5.54

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	3630	4.34
PARAFFINS	3360000	3980
OLEFINS	2010000	2340
TOTAL AROMATICS	11600000	12900
TOTAL HALOGENATED HC	6110000	13600
TOTAL OXYGENATED HC	2810	4.69(B)
SULFUR SPECIES	2140	5.54
UNIDENTIFIED VOC	3630	4.34(C)
TOTAL NMHC	23100000	32800

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

Appendix O
Analytical Results for Gas-Phase 55-Gallon Drum Removal

FIELD ID NO: CANISTER INLET
SAMPLE CONTROL NO: U-109
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/18/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
N-PENTANE	0.0106	31.2
ISOHEXANE	0.00918	32.4
3-METHYLPENTANE	0.01	35.4
N-HEXANE	0.0146	51.4
CYCLOHEXANE	0.124	426
ISOHEPTANE	1.46	5970
3-METHYLHEXANE	1.34	5480
N-HEPTANE	1.9	7790
METHYLCYCLOHEXANE	2.14	8610
2,5-DIMETHYLHEXANE	0.00795	37.1
N-DECANE	0.0198	115
C7 ALKANE	0.397	1630
C7 ALKANE	0.381	1560
C7 ALKANE	0.791	3240
C8 ALKANE	0.0344	161
C10+ ALKANE	0.00848	49.4
C10+ ALKANE	0.00908	52.8
C10+ ALKANE	0.00842	49
C10+ ALKANE	0.0111	64.6
TOTAL AROMATICS		
BENZENE	12.4	39400
TOLUENE	12.4	46600
ETHYLBENZENE	0.0769	334
P-XYLENE/M-XYLENE	0.13	565
STYRENE	0.00896	38.2
1,2,4-TRIMETHYLBENZENE	0.0246	121
C9 AROMATIC	0.144	710
C10+ AROMATIC	0.014	76.8
TOTAL HALOGENATED HC		
CHLOROMETHANE	0.718	1480
BROMOMETHANE	0.0502	195
TRICHLOROFLOROMETHANE	0.167	932(A)
METHYLENE CHLORIDE	0.0388	135
T-1,2-DICHLOROETHYLENE	0.0426	169
CHLOROFORM	0.123	601

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL HALOGENATED HC (CONT'D)		
1,2-DICHLOROETHANE	17.9	72300
CARBON TETRACHLORIDE	0.00329	20.7
CHLOROBENZENE	0.46	2120
P-DICHLOROBENZENE	0.00228	13.7
O-DICHLOROBENZENE	0.0208	125
UNIDENTIFIED HALOGENATED HC	0.0152	70.4
TOTAL OXYGENATED HC(B)		
ACETALDEHYDE	0.052	93.8
PARAFFINS	8.67	35400
TOTAL AROMATICS	25.1	87900
TOTAL HALOGENATED HC	19.3	77200
TOTAL OXYGENATED HC	0.052	93.8(B)
TOTAL NMHC	53.1	200000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

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        FIELD ID NO:  CANISTER OUTLET                                          DATE SAMPLED:    08/18/84
        SAMPLE CONTROL NO:  U-110                                              DATE ANALYZED:   09/01/84
        SAMPLE TYPE:   CANISTER
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        COMPOUND                       CONCENTRATION                COMPOUND                   CONCENTRATION
        ---------                    (PPMV)   (UG/M**3)            ---------                 (PPMV)   (UG/M**3)
                                    --------------------                                    ------------------
PARAFFINS                                                 TOTAL AROMATICS
---------                                                 ---------------
 C-3 VOC                              0.105      181       BENZENE                         0.0422      135
 ISOBUTANE                            0.224      531       TOLUENE                         0.0591      223
 N-BUTANE                            0.0438      104       P-XYLENE/M-XYLENE                0.012     51.9
 ISOPENTANE                           0.103      305       STYRENE                        0.00651     27.7
 N-PENTANE                           0.0108     31.8       O-XYLENE                       0.00671     29.2
 CYCLOPENTANE                       0.00768       22       P-ETHYLTOLUENE                 0.00239     11.7
 2,3-DIMETHYLBUTANE                  0.0041     14.5       1,2,4-TRIMETHYLBENZENE         0.00809     39.8
 2,4-DIMETHYLPENTANE                 0.0646      265       INDENE                          0.0023     10.9
 CYCLOHEXANE                         0.0322      111       M-DIETHYLBENZENE               0.00226     12.4
 ISOHEPTANE                          0.0161     66.2       C9 AROMATIC                     0.0247      121
 3-METHYLHEXANE                     0.00691     28.3       C10+ AROMATIC                  0.00481     26.4
 N-HEPTANE                           0.0196     80.2
 METHYLCYCLOHEXANE                   0.0231       93      TOTAL HALOGENATED HC
 2,2,5-TRIMETHYLHEXANE              0.00255     13.4      --------------------
 N-UNDECANE                         0.00517     33.1       CHLOROMETHANE                    0.287      593
 C7 ALKANE                          0.00354     14.5       VINYL CHLORIDE                     8.2    21000
 C7 ALKANE                          0.00224     9.19       CHLOROETHANE                       7.3    19300
 C7 ALKANE                          0.00414       17       DICHLORODIFLUOROMETHANE           4.74    23300
 C8 ALKANE                          0.00626     29.3       METHYLENE CHLORIDE                 2.6     9030
 C9 ALKANE                          0.00269     14.1       CHLOROFORM                     0.00465     22.7
 C10+ ALKANE                        0.00881     51.3       1,2-DICHLOROETHANE              0.0464      188
 C10+ ALKANE                        0.00465     27.1       1,1,1-TRICHLOROETHANE            0.322     1760
 C10+ ALKANE                        0.00301     17.5       TETRACHLOROETHYLENE            0.00272     18.4
 C10+ ALKANE                         0.0147     85.6       CHLOROBENZENE                   0.0197     90.6
 C10+ ALKANE                        0.00275       16       BICHLOROETHYL ETHER            0.00713     41.7
 C10+ ALKANE                         0.0114     66.3       O-DICHLOROBENZENE              0.00587     35.3
 C10+ ALKANE                        0.00487     28.3       1,1-DICHLOROETHANE              0.0081     32.8
 C10+ ALKANE                        0.00878     51.1       UNIDENTIFIED HALOGENATED HC    0.00297     13.7
 C10+ ALKANE                        0.00368     21.4       UNIDENTIFIED HALOGENATED HC    0.00186     8.58
 C10+ ALKANE                         0.0052     30.3
 C10+ ALKANE                         0.0038     22.1      TOTAL OXYGENATED HC(B)
 C10+ ALKANE                        0.00335     19.5      ----------------------
 C10+ ALKANE                        0.00591     34.4       BUTYRALDEHYDE                   0.0335     98.8

OLEFINS                                                   UNIDENTIFIED VOC(C)
-------                                                   -------------------
 1,3-BUTADIENE                        0.196      434       UNIDENTIFIED VOC               0.00758     26.7
 2,4,4-TRIME-1-PENTENE              0.00255     11.7
 LIMONENE                           0.00434     24.2

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(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

 *   UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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FIELD ID NO: CANISTER OUTLET
SAMPLE CONTROL NO: U-110
SAMPLE TYPE: CANISTER

DATE SAMPLED: 08/18/84
DATE ANALYZED: 09/01/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)	COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS	0.768	2430			
OLEFINS	0.203	470			
TOTAL AROMATICS	0.171	689			
TOTAL HALOGENATED HC	23.5	75300			
TOTAL OXYGENATED HC	0.0335	98.8(B)			
UNIDENTIFIED VOC	0.00758	26.7(C)			
TOTAL NMHC	24.7	78900			

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

Appendix P

Analytical Results for Clean Drum Carbon Analysis

FIELD ID NO: CHARCOAL CANISTER TEST
SAMPLE CONTROL NO: U108
SAMPLE TYPE: SOLID

DATE SAMPLED: 08/17/84
DATE ANALYZED: 10/25/84

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
PARAFFINS		
C-3 VOC	380	0.444
ISOBUTANE	1100	1.33
METHYLCYCLOPENTANE	1310	1.53
CYCLOHEXANE	7180	8.4
ISOHEPTANE	14700	17.5
N-HEPTANE	8230	9.82
METHYLCYCLOHEXANE	11800	13.8
C6 ALKANE	6270	7.51
C7 ALKANE	22400	26.7
C7 ALKANE	5230	6.24
C8 ALKANE	238	0.283
C8 ALKANE	332	0.395
C8 ALKANE	4650	5.53
C8 ALKANE	1420	1.69
C9 ALKANE	232	0.276
C10+ ALKANE	1120	1.33
OLEFINS		
1-PENTENE	1680	1.96
C7 ALKENE	7330	8.57
TOTAL AROMATICS		
BENZENE	32900	35.7
TOLUENE	17900	19.6
TOTAL HALOGENATED HC		
CHLOROFORM	518	5.15
1,2-DICHLOROETHANE	9760	40.3
1,1,1-TRICHLOROETHANE	2770	15.4
CARBON TETRACHLORIDE	296	3.79
TETRACHLOROETHYLENE	117	0.808
CHLOROBENZENE	1890	2.96
UNIDENTIFIED HALOGENATED HC	321	1.01

COMPOUND	CONCENTRATION (NG-C/G)	CONCENTRATION (UG/G)*
TOTAL OXYGENATED HC(B)		
2-PENTANONE	27600	39.6
VALERALDEHYDE	13200	18.9
UNIDENTIFIED VOC(C)		
UNIDENTIFIED VOC	4340	5.18
UNIDENTIFIED VOC	1040	1.24
UNIDENTIFIED VOC	447	0.534
PARAFFINS	86600	103
OLEFINS	9010	10.5
TOTAL AROMATICS	50800	55.3
TOTAL HALOGENATED HC	15700	69.4
TOTAL OXYGENATED HC	40800	58.5(B)
UNIDENTIFIED VOC	5830	6.96(C)
TOTAL NMHC	168000	245

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

Appendix Q
Canister Speciation Results for Samples Taken within the Dome

FIELD ID NO: LAGOON AIR HATCH - SE CORNER
SAMPLE CONTROL NO: U-007
SAMPLE TYPE: CANISTER

DATE SAMPLED: 07/18/84
DATE ANALYZED: 07/20/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.583	1000
ISOHEXANE	0.46	1620
3-METHYLPENTANE	0.705	2490
N-HEXANE	1.17	4140
ISOHEPTANE	0.487	2000
3-METHYLHEXANE	0.409	1670
N-HEPTANE	0.571	2340
METHYLCYCLOHEXANE	0.496	1990
N-DECANE	3.1	18000
N-UNDECANE	4.62	29500
C9 ALKANE	0.338	1770
C9 ALKANE	5.79	30400
C10+ ALKANE	1.04	6050
C10+ ALKANE	2.33	13600
OLEFINS		
1-NONENE	9.58	49400
4-NONENE	7.54	38900
A-PINENE	2.8	15600
1-DECENE	4.67	26800
LIMONENE	3.1	17300
1-UNDECENE	7.1	44800
C9 ALKENE	7.14	36900
C10+ ALKENE	8.43	48400
C10+ ALKENE	21.3	122000
C10+ ALKENE	25.4	146000
C10+ ALKENE	2.88	16500
C10+ ALKENE	3.07	17600
C10+ ALKENE	19.4	111000
C10+ ALKENE	3.6	20700
C10+ ALKENE	19.1	110000
C10+ ALKENE	2.37	13600
C10+ ALKENE	4.39	25200
TOTAL AROMATICS		
BENZENE	2.02	6440
TOLUENE	151	570000

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
TOTAL AROMATICS (CONT'D)		
ETHYLBENZENE	0.586	2550
P-XYLENE/M-XYLENE	1.91	8310
O-XYLENE	23.8	103000
ISOPROPYLBENZENE	1.64	8080
N-PROPYLBENZENE	0.726	3570
M-ETHYLTOLUENE	0.644	3170
1,3,5-TRIMETHYLBENZENE	1.92	9450
O-ETHYLTOLUENE	2.92	14400
T-BUTYLBENZENE	4.06	22300
1,2,4-TRIMETHYLBENZENE	7.62	37500
ISOBUTYLBENZENE	5.21	28600
1,2,3-TRIMETHYLBENZENE	1.28	6280
INDAN	6.2	30000
M-DIETHYLBENZENE	7.14	39200
N-BUTYLBENZENE	4.86	26700
P-DIETHYLBENZENE	2.08	11400
NAPHTHALENE	0.739	3870
C9 AROMATIC	1.46	7160
C9 AROMATIC	0.819	4030
C10+ AROMATIC	1.29	7080
C10+ AROMATIC	1.83	10000
C10+ AROMATIC	2.54	13900
C10+ AROMATIC	1.66	9110
C10+ AROMATIC	1.32	7250
C10+ AROMATIC	0.699	3840
C10+ AROMATIC	0.594	3260
TOTAL HALOGENATED HC		
1,2-DICHLOROETHANE	680	2750000
CHLOROBENZENE	67	309000
UNIDENTIFIED HALOGENATED HC	5.27	24300
UNIDENTIFIED HALOGENATED HC	3.8	17600
PARAFFINS	22.1	117000
OLEFINS	152	861000
TOTAL AROMATICS	239	1000000
TOTAL HALOGENATED HC	756	3100000
TOTAL NMHC	1170	5080000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

FIELD ID NO: LAGOON AIR HATCH - SW CORNER
SAMPLE CONTROL NO: U-008
SAMPLE TYPE: CANISTER

DATE SAMPLED: 07/18/84
DATE ANALYZED: 07/20/84

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
PARAFFINS		
C-3 VOC	0.673	1160
ISOHEXANE	0.422	1490
3-METHYLPENTANE	0.713	2510
N-HEXANE	1.12	3950
ISOHEPTANE	0.484	1980
3-METHYLHEXANE	0.429	1760
N-HEPTANE	0.537	2200
METHYLCYCLOHEXANE	0.514	2070
2,2,5-TRIMETHYLHEXANE	0.159	833
N-OCTANE	0.185	864
N-DECANE	3.16	18400
N-UNDECANE	3.91	25000
C7 ALKANE	0.167	685
C7 ALKANE	0.128	525
C9 ALKANE	0.177	927
C9 ALKANE	5.92	31100
C10+ ALKANE	0.996	5800
C10+ ALKANE	2.1	12200
C10+ ALKANE	0.243	1410
OLEFINS		
1-NONENE	9.81	50600
4-NONENE	7.67	39600
A-PINENE	2.83	15800
1-DECENE	4.9	28100
LIMONENE	3.04	16900
1-UNDECENE	6.26	39500
C9 ALKENE	7.36	38000
C9 ALKENE	1.34	6940
C9 ALKENE	0.729	3760
C10+ ALKENE	8.96	51400
C10+ ALKENE	21.4	123000
C10+ ALKENE	26	149000
C10+ ALKENE	2.72	15600
C10+ ALKENE	30.4	174000
C10+ ALKENE	18.5	106000
C10+ ALKENE	3.24	18600
C10+ ALKENE	17.6	101000

COMPOUND	CONCENTRATION (PPMV)	CONCENTRATION (UG/M**3)
OLEFINS (CONT'D)		
C10+ ALKENE	1.6	9180
C10+ ALKENE	1.13	6480
C10+ ALKENE	2.04	11700
C10+ ALKENE	3.9	22400
C10+ ALKENE	0.494	2830
C10+ ALKENE	0.215	1230
C10+ ALKENE	0.317	1820
TOTAL AROMATICS		
BENZENE	2.32	7400
TOLUENE	166	624000
ETHYLBENZENE	0.36	1560
P-XYLENE/M-XYLENE	1.66	7220
O-XYLENE	26.1	113000
ISOPROPYLBENZENE	1.49	7320
N-PROPYLBENZENE	0.606	2980
M-ETHYLTOLUENE	0.497	2440
P-ETHYLTOLUENE	1.83	9010
O-ETHYLTOLUENE	31.2	153000
T-BUTYLBENZENE	4.17	22900
1,2,4-TRIMETHYLBENZENE	7.98	39200
ISOBUTYLBENZENE	5.41	29700
1,2,3-TRIMETHYLBENZENE	1.22	6010
INDAN	6.32	30600
M-DIETHYLBENZENE	7.14	39200
N-BUTYLBENZENE	4.76	26100
P-DIETHYLBENZENE	1.96	10800
NAPHTHALENE	0.686	3600
C10+ AROMATIC	1.15	6310
C10+ AROMATIC	2.08	11400
C10+ AROMATIC	1.39	7630
C10+ AROMATIC	0.561	3080
TOTAL HALOGENATED HC		
1,2-DICHLOROETHANE	650	2630000
CHLOROBENZENE	61.0	285000

(A) ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B) VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C) CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

* UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.

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        FIELD ID NO:  LAGOON AIR HATCH - SW CORNER                                          DATE SAMPLED:    07/18/84
        SAMPLE CONTROL NO:  U-008                                                           DATE ANALYZED:   07/20/84
        SAMPLE TYPE:   CANISTER
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                                           CONCENTRATION                                                         CONCENTRATION
       COMPOUND                          (PPMV)   (UG/M**3)            COMPOUND                                (PPMV)   (UG/M**3)
       --------                          ------------------            --------                                ------------------

TOTAL OXYGENATED HC(B)
-------------------
 METHANOL                                   1.2       1570

PARAFFINS                                    22     115900
OLEFINS                                     182    1030000
TOTAL AROMATICS                             277    1170000
TOTAL HALOGENATED HC                        712    2920000
TOTAL OXYGENATED HC                         1.2       1570(B)

TOTAL NMHC                                 1190    5230000

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(A)  ARTIFACT COMPOUND - CONCENTRATION NOT USED IN TOTAL NMHC CALCULATIONS.
(B)  VARIABLE RECOVERY THROUGH DRYING SYSTEM - CONCENTRATIONS NOT USED IN TOTAL NMHC CALCULATIONS.
(C)  CONCENTRATIONS WERE CALCULATED USING VALUES OF 6 FOR THE CARBON NUMBER AND 86 FOR THE MOLECULAR WEIGHT.

  *  UNITS ARE EQUIVALENT TO PPM ASSUMING A DENSITY OF 1.
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Appendix R

Results of Quality Control Checks for On-Site Analyzers

TABLE R-1. RESULTS OF ON-SITE QUANTITATIVE STANDARD ANALYSES FOR BYRON 401's, MULTIPOINT LINEARITY CHECKS

Instrument	Gas	Date	Average Response Factor	Correlation Coefficient
Byron 401	Toluene[a]	8-15-84	0.8108	0.9994
	Mixed Standard[b]	8-15-84	0.8527	1.0000
	Mixed Standard[b]	8-16-84	0.8381	0.9996
	Mixed Standard[b]	8-17-84	0.8660	0.9999
	Mixed Standard[b]	8-18-84	0.8578	0.9999
Byron Super 401	Toluene[a]	8-15-84	0.8449	0.9999
	Mixed Standard[b]	8-15-84	0.8262	0.9999
	Mixed Standard[b]	8-16-84	0.7921	0.9999
	Mixed Standard[b]	8-17-84	0.7960	0.9999
	Mixed Standard[b]	8-18-84	0.7684	0.9999

[a] Concentrations used were 200, 2000, and 5000 ppmv-c

[b] Mixed standard - Benzene, Toluene and Chlorobenzene concentrations used were 50, 500, and 5000 ppmv-c.

TABLE R-2 . RESULTS OF ON-SITE QUANTITATIVE STANDARD ANALYSES FOR BYRON 401's, MULTIPOINT LINEARITY CHECKS

Instrument	Date	Test Type	Average Measured Concentration (ppmv)	True Value (ppmv)	% Difference
Byron	8-16-84	Single Point	491.9	496.6	-0.95
		Single Point	461.5	496.6	-7.07
		Drift Check	328.7	386.1	-14.9
	8-17-84	Single Point	470.8	496.6	-5.20
		Drift Check	376.6	386.1	-2.46
	8-18-84	Single Point	470.0	496.6	-5.36
		Drift Check	364.4	386.1	-5.62
	8-19-84	Drift Check	356.5	386.1	-7.67
Byron Super 401	8-16-84	Single Point	473.5	496.6	-4.65
		Single Point	409.1	496.6	-17.6
		Drift Check	360.6	386.1	-6.60
	8-17-84	Single Point	428.5	496.6	-13.7
		Drift Check	386.1	386.1	0
	8-18-84	Single Point	441.6	496.6	-11.1
		Drift Check	354.6	386.1	-8.16
	8-19-84	Drift Check	379.6	386.1	-1.68

TABLE R-3. ANALYTICAL SYSTEM BLANKS PERFORMED ON-SITE

Instrument	Date	Total Hydrocarbon ppmv-c
Byron 401	8-15-84	1.0
		1.8
	8-16-84	3.1
		3.1
	8-17-84	1.6
		1.5
	8-18-84	2.8
		2.8
	8-19-84	1.2
Byron Super 401	8-15-84	0.5
		1.0
	8-16-84	0.6
		0.6
	8-17-84	1.7
		1.7
	8-18-84	0.8
		0.9
	8-19-84	0.5

Appendix S
Results of Quality Control Checks for Off-Site Analyzers

TABLE S-1. RESULTS OF OFF-SITE ANALYSIS OF 12 COMPONENT STANDARDS FOR SPECIES IDENTIFICATION CHECK

Compound	10-8-84			10-9-84		
	Measured Concentration (ppbv-c)	Δ % From True Concentration	ID	Measured Concentration (ppbv-c)	Δ % From True Concentration	ID
Ethane	31.1	5.1	-	31.5	6.4	-
Propane	122.4	-.16	+	123.4	0.65	+
1-Butene	56.4	-13.1	+	56.7	-12.7	+
n-Butane	62.9	4.0	+	62.8	3.8	+
1-Hexene	83.3	-10.6	+	82.6	-11.4	+
n-Hexane	90.1	3.7	-	87.2	.37	-
Ethyl benzene	98.9	-23.6	+	105.0	-18.9	+
n-Octane	112.7	-14.9	+	112.6	-15.0	+
Propyl benzene	94.4	3.5	+	96.7	6.1	+
n-Decane	120.6	-30.1	+	126.9	-26.5	+
Benzene	85.4	43.7	+	84.7	42.5	+
Toluene	100.2	-3.0	+	102.7	-5.8	+

+ = Correct identification
- = Incorrect identification

TABLE S-2. RESULTS OF OFF-SITE ANALYSIS OF PID/FID DAILY SINGLE POINT CALIBRATION STANDARD

Date	Propane			Hexane		
	RF	Multipoint RF	Δ % C	RF	Multipoint RF	Δ % C
9-26-84	568.35	547.15	3.87	578.77	544.22	6.35
9-27-84	561.89	547.15	2.69	569.59	544.22	4.66
9-28-84	544.50	547.15	-0.484	560.83	544.22	3.10
9-30-84	545.63	547.15	-0.278	555.52	544.22	2.08
10-01-84	535.01	547.15	-2.22	553.10	544.22	1.63
10-02-84	539.13	547.15	-1.47	545.81	544.22	0.296
10-03-84	537.87	547.15	-1.7	555.56	544.22	2.08
10-09-84	515.20	547.15	-5.83	529.73	544.22	2.7
10-10-84	517.30	547.15	-5.5	526.71	544.22	-3.22
10-11-84	488.36	547.15	12.0	494.45	544.22	-9.15
10-12-84	513.46	547.15	-6.2	519.55	544.22	-4.5
10-15-84	522.35	547.15	-4.5	526.96	544.22	-3.2
10-16-84	518.52	547.15	-5.23	532.28	544.22	-2.19
10-17-84	508.45	530.58	-4.17	514.14	533.63	-3.65
10-18-84	502.39	530.58	-5.31	511.92	533.63	-4.07
10-19-84	499.32	530.58	-5.89	511.80	533.63	-4.09
10-22-84	495.43	530.58	-6.62	494.49	533.63	-7.33
10-23-84	538.49	530.58	1.49	550.05	533.63	3.08
10-24-84	533.70	530.58	-2.5	542.31	533.63	1.63
10-25-84	529.04	530.58	-0.29	541.87	533.63	1.5

[a] mean response factor for propane

[b] mean response factor for hexane

[c] $\frac{RF - \overline{RF}}{RF}$ 100%

TABLE S-3. RESULTS OF OFF-SITE ANALYSIS OF HECD QUANTITATIVE STANDARD

Compound	10-02-84		10-03-84		10-08-84		10-09-84		10-10-84		10-11-84	
	(RF)	(%Error)	(RF)	(% Error)	(RF)	(% Error)	(RF)	(% Error)	(RF)	(% Error)	(RF)	(%)
Chloromethane	0.178	(-9.0)	.187	(-6.5)	.431	(15.9)	.445	(9.3)	.201	(.35)	.212	(6.0)
Vinyl chloride	.760	(-2.6)	.770	(-1.3)	1.80	(15.2)	1.82	(14.3)	.896	(14.9)	.868	(11.3)
Dichlorodifluoromethane	.398	(-5.2)	.415	(-1.2)	.963	(12.6)	.989	(15.7)	.479	(14.0)	.467	(4.2)
Fluorotrichloromethane	.132	(-5.7)	.129	(-7.9)	.304	(6.7)	.300	(5.3)	.152	(8.6)	.140	(0)
1,1-Dichloroethylene	.416	(-9.5)	.403	(4.0)	.957	(11.9)	.947	(10.8)	.492	(17.1)	.436	(3.8)
Methylene chloride	.220	(0)	.205	(-6.8)	.485	(8.3)	.486	(8.5)	.240	(9.1)	.223	(1.4)
t-1,2-Dichloroethene	.474	(-1.2)	.441	(-8.1)	1.06	(8.9)	1.05	(7.6)	.531	(10.6)	.498	(3.8)
1,1-Dichloroethane	.417	(-0.7)	.391	(-6.9)	.918	(7.4)	.924	(8.1)	.425	(1.2)	.409	(-2.6)
Chloroform	.140	(0)	.136	(-2.9)	.318	(11.6)	.311	(9.1)	.160	(14.3)	.147	(5.0)
1,2-Dichloroethane	.576	(2.9)	.599	(0.7)	1.35	(18.4)	1.34	(17.4)	.663	(18.4)	.637	(13.8)
1,1,1-Trichloroethane	.287	(-1.0)	.268	(-7.6)	.611	(3.6)	.614	(4.0)	.314	(8.3)	.284	(-2.1)
Carbon tetrachloride	.128	(-1.5)	.122	(-6.2)	.296	(11.7)	.299	(13.0)	.156	(20)	.145	(16.5)
1,2-Dichloropropane	.675	(-4.9)	.667	(-6.1)	1.53	(5.6)	1.59	(9.9)	.801	(12.8)	.715	(0.70)
Trichloroethylene	.302	(0.6)	.297	(-1.0)	.680	(11.3)	.672	(10.0)	.334	(11.3)	.314	(4.7)
1,1,2-Trichloroethane	.463	(-1.5)	.442	(0.6)	1.08	(12.3)	1.05	(10.0)	.547	(16.4)	.502	(6.8)
Tetrachloroethylene	.258	(-0.7)	.250	(-3.8)	.569	(7.6)	.572	(8.1)	.286	(10)	.275	(5.8)
Chlorobenzene	5.12	(6.2)	4.62	(-4.0)	11.2	(14.3)	11.1	(13.1)	5.91	(22.7)	5.52	(14.5)
Average Response Factor	.364		.358		.834		.838		.417		.392	

TABLE S-3. (Continued)

Compound	10-22-84 (RF)	10-22-84 (% Error)	10-23-84 (RF)	10-23-84 (% Error)	10-24-84 (RF)	10-24-84 (% Error)	10-25-84 (RF)	10-25-84 (% Error)
Chloromethane	.462	(-25.5)	.566	(-8.7)	.251	(-17.6)	.248	(-18.6)
Vinyl chloride	2.09	(-22.3)	2.44	(-9.5)	1.10	(-16.4)	1.08	(-18.3)
Dichlorodifluoromethane	1.11	(-21.2)	.855	(-39.4)	.592	(-14.5)	.587	(-15.2)
Fluorotrichloromethane	.353	(-13.9)	.368	(-10.2)	1.89	(-6.2)	1.87	(-7.1)
1,-Dichloroethylene	1.13	(-13.7)	1.24	(-5.5)	.608	(-5.4)	.598	(-7.0)
Methylene chloride	.571	(-13.5)	.667	(1.1)	.314	(-5.7)	.311	(-6.6)
t-1,2-Dichloroethene	1.24	(-14.5)	1.38	(-5.1)	.666	(-6.5)	.659	(-7.4)
1,1-Dichloroethane	1.09	(-10.2)	1.20	(-1.2)	.594	(-0.05)	.573	(-3.6)
Chloroform	.387	(-12.0)	.437	(-6.8)	.215	(-0.5)	.213	(-1.4)
1,2-Dichloroethane	1.41	(-7.4)	1.58	(4.0)	.779	(4.3)	.757	(1.4)
1,1,1-Trichloroethane	.749	(-9.8)	.834	(-4.8)	.399	(-2.1)	.390	(-4.3)
Carbon tetrachloride	.372	(-2.1)	.392	(3.2)	.201	(7.7)	.193	(3.4)
1,2-Dichloropropane	1.84	(10.8)	1.83	(10.1)	1.01	(23.9)	.977	(19.9)
Trichloroethylene	.797	(-11.4)	.927	(30)	.445	(6.8)	.432	(-2.3)
1,1,2-Trichloroethane	1.21	(-8.9)	1.63	(29.4)	.701	(13.3)	.707	(14.2)
Tetrachloroethylene	.660	(-9.6)	.775	(6.2)	.386	(7.7)	.371	(3.5)
Chlorobenzene	13.0	(-0.6)	16.2	(23.7)	7.54	(17.0)	7.52	(16.1)
Average Response Factor	.997		1.07		.528		.518	

RF = Response Factor

TABLE S-4. RESULTS OF DAILY OFF-SITE ANALYTICAL SYSTEM BLANKS FOR FLAME IONIZATION DETECTOR AND PHOTOIONIZATION DETECTOR

Date	Total Nonmethane Hydrocarbon (ppbv-c)	Blank Type
9-27-84	34.8	Water
10-02-84	54.2	Water
10-03-84	57.0	Water
10-05-84	26.3	Gas
10-08-84	7.21	Gas
10-09-84	5.61	Gas
10-15-84	13.2	Gas
10-16-84	11.9	Gas
10-17-84	8.60	Gas
10-18-84	7.21	Gas
10-19-84	21.7	Gas
10-22-84	53.0	Gas
10-04-84	103	Water α Tetraglyme
10-05-84	90.2	Water α Tetraglyme
10-10-84	92.1	Water α Tetraglyme
10-11-84	61.1	Water α Tetraglyme
10-12-84	95.4	Water α Tetraglyme
10-24-84	103	Water α Tetraglyme
10-25-84	77.8	Water α Tetraglyme

TABLE S-5. RESULTS OF DAILY OFF-SITE ANALYTICAL SYSTEM BLANKS FOR HALL (HECD) DETECTOR

Date	Total Nonmethane Hydrocarbon (ppbv-c)	Blank Type
9-26-84	4.82	Water
9-27-84	2.83	Water
10-02-84	3.32	Water
10-03-84	3.10	Water
10-05-84	4.90	Gas
10-08-84	6.20	Gas
10-09-84	1.20	Gas
10-15-84	0.65	Gas
10-16-84	0.13	Gas
10-17-84	0.82	Gas
10-18-84	0.022	Gas
10-19-84	9.32	Gas
10-22-84	32.1	Gas
10-04-84	5.60	Water α Tetraglyme
10-05-84	4.39	Water α Tetraglyme
10-10-84	7.95	Water α Tetraglyme
10-11-84	1.13	Water α Tetraglyme
10-12-84	1.41	Water α Tetraglyme
10-24-84	0.15	Water α Tetraglyme
10-25-84	1.92	Water α Tetraglyme

TABLE S-6. RESULTS OF OFF-SITE ANALYSIS OF EPA QUALITY CONTROL SAMPLE FOR VOLATILES (FID/PID DETECTOR)

Compound	True Value (ug/L)	Analytical Result (% Recovery)				
		10-03-84 Measured Value (ug/L) % Recovery	10-10-84 Measured Value (ug/L) % Recovery	10-11-84 Measured Value (ug/L) % Recovery	10-24-84 Measured Value (ug/L) % Recovery	10-25-84 Measured Value (ug/L) % Recovery
Methylene chloride	1.41	0.9 (157)	2.08 (148)	1.8 (128)	2.6 (184)	3.4 (241)
1,1-Dichloroethane	2.48	1.3 (91)	1.53 (62)	1.4 (56)	1.8 (73)	1.3 (52)
trans-1,2-Dichloroethylene	2.48	1.4 (177)	1.42 (57)	1.5 (60)	1.4 (56)	1.4 (56)
1,2-Dichloroethane	2.42	1.8 (134)	2.33 (96)	1.9 (78)	2.3 (95)	2.0 (83)
Carbon tetrachloride	0.781	0.4 (195)	0.679 (87)	-	3.3 (422)	0.4 (55)
Trichloroethene	1.83	1.4 (131)	6.36 (348)	-	7.0 (382)	1.2 (66)
Dibromochloromethane	0.733	-	0.359 (49)	0.400 (55)	0.7 (95)	0.5 (68)
1,1,2,2-Tetrachloroethane	1.43	1.21 (118)	1.59 (111)	2.5 (175)	1.3 (91)	1.3 (91)
Chlorobenzene	6.40	4.8 (75)	4.73 (74)	4.8 (75)	4.4 (69)	4.9 (77)
Benzene	9.23	6.9 (75)	6.88 (75)	7.2 (78)	1.3 (141)	7.0 (84)
Toluene	9.13	7.8 (85)	7.95 (87)	8.1 (89)	8.3 (91)	8.1 (89)
Ethylbenzene	9.05	7.9 (87)	7.66 (85)	8.1 (90)	7.4 (82)	8.3 (92)

TABLE S-7. RESULTS OF OFF-SITE ANALYSIS OF EPA QUALITY CONTROL SAMPLE FOR VOLATILES (HECD DETECTOR)

Compound	True Value (ug/L)	Analytical Result (% Recovery)									
		10-03-84 Measured Value (ug/L)	% Recovery	10-10-84 Measured Value (ug/L)	% Recovery	10-11-84 Measured Value (ug/L)	% Recovery	10-24-84 Measured Value (ug/L)	% Recovery	10-25-84 Measured Value (ug/L)	% Recovery
Methylene chloride	1.41	1.70	(120)	1.44	(103)	1.34	(95)	1.50	(106)	1.45	(103)
1,1-Dichloroethane	2.48	1.80	(72)	1.77	(71)	1.71	(69)	1.55	(63)	1.74	(70)
trans-1,2-Dichloroethylene	2.48	2.15	(87)	2.24	(90)	2.17	(88)	2.10	(85)	2.24	(90)
1,2-Dichloroethane	2.42	3.68	(152)	3.64	(150)	3.43	(142)	3.18	(132)	3.28	(136)
Carbon tetrachloride	0.781	0.742	(95)	0.803	(103)	0.670	(86)	0.897	(115)	0.843	(108)
Trichloroethene	1.83	1.84	(100)	1.82	(99)	1.56	(85)	1.88	(102)	1.92	(105)
Dibromochloromethane	0.733	1.29	(176)	1.25	(170)	1.03	(140)	1.05	(143)	1.03	(141)
1,1,2,2-Tetrachloroethane	1.43	2.54	(178)	2.66	(186)	2.31	(161)	2.34	(164)	2.51	(176)
Chlorobenzene	6.40	13.6	(213)	13.4	(210)	11.3	(177)	22.2	(347)	12.6	(197)

TABLE S-8. SUMMARY OF DUPLICATE ANALYSES PERFORMED ON VARIAN GC

Sample ID Number	Sample Type	Measured Concentration[a]				
		Paraffins	Olefins	Aromatics	Halogenated Hydrocarbons	Total Non-methane Hydrocarbons
U028	Liquid	16.5	--	30.9	25.1	72.4
		7.90	--	34.0	31.6	74.7
U028D	Liquid	4.06	0.39	31.9	32.8	69.2
		20.0	--	29.2	31.0	80.1
U034	Sludge	165	60.0	180	3.0	464
		151	38.9	50.4	14.0	264
U035	Sludge	41.5	10.7	49.9	9.8	123
		37.1	13.0	90.8	6.7	151
U036	Sludge	118	54.5	441	261	927
		76.4	19.7	57.3	126	279
U060	Gas	44,300	7630	137,000	51,900	240,000
		59,300	--	144,000	99,600	303,000

Units are liquid mg/L
Sludge ug/g
Gas ug/m^3